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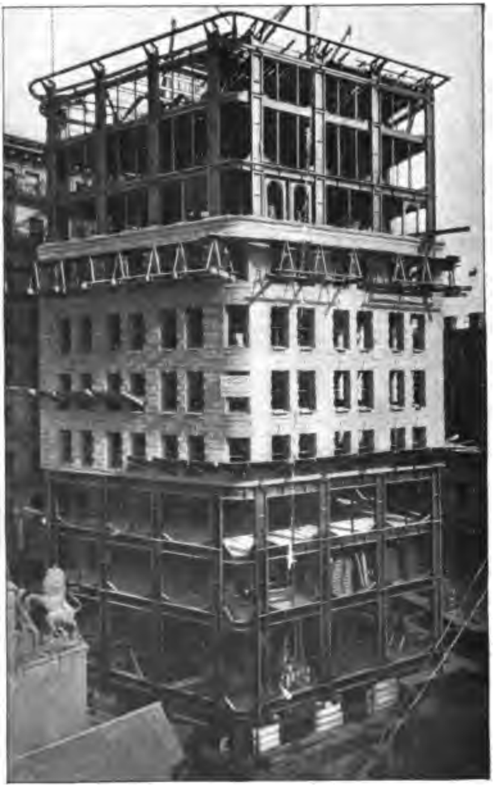

**BRAZER BUILDING, STATE AND DEVONSHIRE STS., BOSTON.**

The steel frame of this building was protected by two coats of our Durable Metal Coating. Cass Gilbert, Architect, St. Paul, Minn.

Edward Smith & Co., 45 Broadway, New York.

# PAINTING
# TO
# PREVENT CORROSION

WITH
SPECIFICATIONS

BY

## A. H. SABIN, M. S.

Member of the American Chemical Society; the American Society of Mechanical Engineers; Associate Member of the American Society of Civil Engineers, etc. Lecturer in New York University; lately Professor of Chemistry in the University of Vermont.

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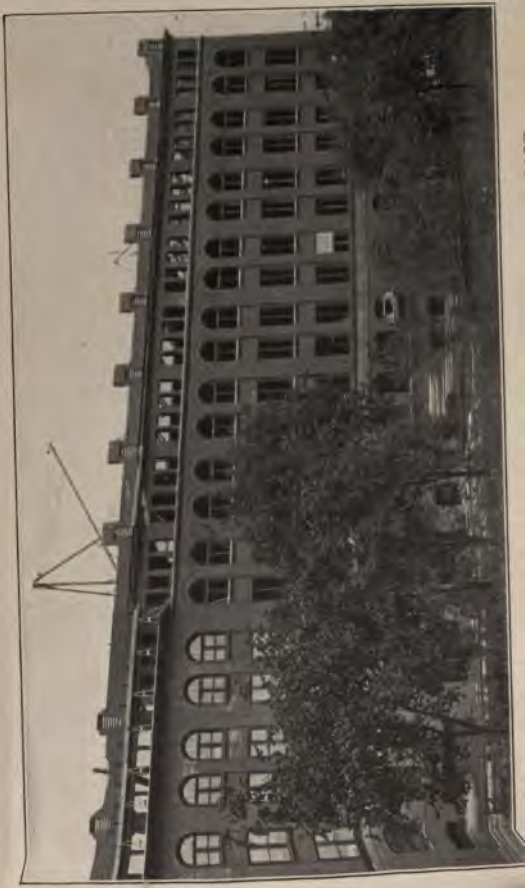


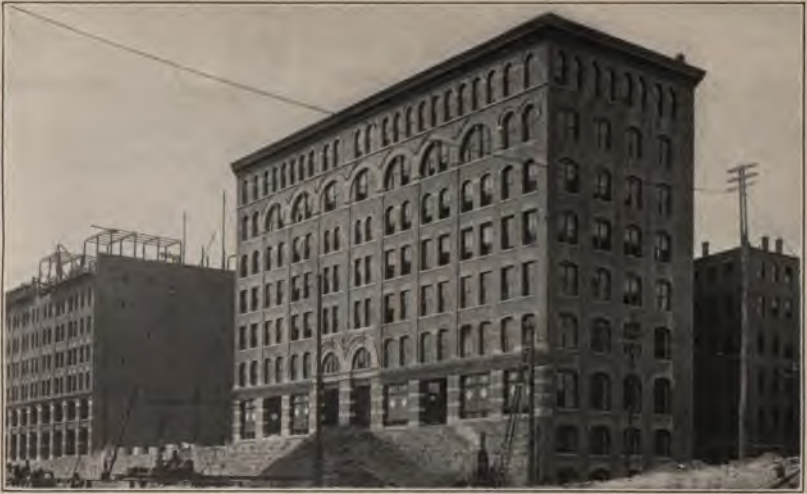
# MEMORANDUM

## I.

# INTRODUCTORY.

THE author of the following pages was recently asked to write some specifications for painting an important structure, which was to be coated first with a preservative against corrosion and finished with a light-colored paint; and it was desired to have as good and thorough work as could be obtained. A rough draft of such specifications was drawn up and submitted to several engineers of experience, from whom valuable criticisms have been received; and it was then decided to publish a small edition of the same, hoping to thereby elicit further criticism and information relating to actual practice, and also to direct attention to the subject. It was decided to draw up specifications calling for very thorough preparation of the surface of the metal before painting; from what I can learn by reading and inquiry, this has been done (by pickling, etc.) somewhat extensively in Europe; but in this country it is practically unknown; it was therefore thought best to add to these another set of specifications, which should apply to work the magnitude of which is not sufficient to warrant the erection of expensive plants for sand-blasting or pickling, and which should represent the best ordinary work. In my opinion we need better and more thorough methods of painting far more than we need a new and improved kind of paint, a comparatively poor paint properly applied to a good surface being better than a good paint on a poor surface.

Paint is specified by three classes of engineers: first, by a few who understand the importance of the matter, and have definite and to some extent original ideas as to the kind of paint and the method of its application, and who will take some trouble to secure good results; second, by a much larger number who do some of these things because the engineers of the former class recommend it;



WAREHOUSE OF THE BOSTON WHARF CO., SOUTH BOSTON, MASS.

# MEMORANDUM

third, by a considerable number who have their metal painted because it is customary and looks well. Either paint is of value in preventing corrosion or it is not; if not, let us stop using it; if it is, let the matter be given enough attention to secure the best attainable results. When an engineer says that he has no time to investigate this matter, he can only justify himself by further assuming that paint is of no value as an engineering material; otherwise he is taking money from his employers for work which he is unable to do. The defence that he has no time is of doubtful validity; we all know that the men who give attention to such matters are the busy men; if you want anything done, always get a busy man to do it. Most men spend a large part of their time doing things which could as well be done by subordinates. The real trouble with very many of our engineers is that they regard paint as having to do, as it has, chiefly with the matter of maintenance; and that whole subject receives far less attention than it should.

A train shed roof belonging to one of the great railroad companies in Massachusetts fell in a few years ago just because it had been neglected and had rusted out; and the contractor who replaced it says the new roof will go the same way. What is the use, says the contractor, of spending a large amount of money and care in getting a fancy job of painting on such work, if it is not to be taken care of afterward? Perhaps it is not worth while; on the other hand, perhaps this sort of work, which certainly needs the best preparation, will repay the outlay better than that which is thoroughly looked after. However, it is not worth while to speculate on this too long, for the engineer who neglects his work after erection certainly will not pay for any very elaborate job of painting in the beginning. He who takes the position that life is too short to be studying this paint question may feel confident that he has good company and plenty of it; but it is not for him that these pages are written, excepting as they may stir him up to a sense of his responsi-

STAMP MILLS OF THE CALUMET & HECLA COPPER CO. AT LAKE LINDEN, MICH.
Corrugated iron buildings painted with our Durable Metal Coating.
Edward Smith & Co., 45 Broadway, N. Y.

# MEMORANDUM

bility. There is, however, no doubt that the subject is one of importance, and is attracting a rapidly increasing amount of attention.

The following specifications relate especially to new work, and inasmuch as every bridge has to be repainted several times the question of specifications for repainting will naturally occur. The author is not at the present time prepared to write such specifications. Shop painting is a much simpler matter, because the conditions are more nearly uniform; and after all, the first coat which goes on to the metal, if it reaches the actual metallic surface, is the most important. But in regard to repainting old structures, it may be remarked that the most important thing is to remove the rust which has already formed. More than a century ago Smeaton said he "had observed that when iron once gets rust, so as to form a scale, whatever coat of paint or varnish is put on over this, the rust will go on progressively under the paint." The following century of observation has made no change in this remark, which is only confirmed by longer experience. The thing to decide is how to get the desired surface. It is impossible to pickle structures which have been erected; the sandblast has been used and gives entirely satisfactory results, but only in what may be regarded as an experimental way, and it is generally thought to be too expensive for general application; aside from that, the best current practice seems to be thorough scraping, using the hammer and chisel to clean out such places as can not otherwise be cleaned, then wire brushing and finally dusting off with a whisk. Some engineers have used the painter's torch freely, and claim that its use renders the removal of rust easier, and by dehydrating it makes less harmful the residue which it is impossible to remove. It does not seem likely in any case to do harm. If the surface is badly corroded, a great deal of work must be put on it before it can be properly painted; and it is quite possible that in the hands of an experienced and practical man the sandblast, which does incomparably better work and is very rapid, may

**DELMONICO BUILDING, 44TH STREET AND FIFTH AVEN**
**NEW YORK CITY.**

The ornamental iron work of this building, by John Williams, 556 W
27th Street, is protected with our Durable Metal Coating.

Edward Smith & Co., 45 Broadway, New York.

# MEMORANDUM

not prove much more expensive and perhaps less so than the best hand work which is now done.

Some engineers regard the practice of naming a particular paint in a specification as objectionable. It does not seem so to me. It is, of course, easy to bring up reasons against such a practice, the most influential one being probably that is exposes the engineer to suspicion of having a bribe from the paint manufacturer.

I do not believe there are many American engineers whose characters are not good enough to clear them from any such suspicion; and those who cannot be indifferent to such a matter probably have not a great deal of reputation to fall back on. The one thing which practically works against this is that it is prohibited in a great deal of public work. But the result is that the public gets a great deal of inferior material. To mention a concrete case: The U. S. Navy Department is obliged to buy varnish on specifications from the lowest bidder. It is impossible with our present knowledge to write varnish specifications which will enable any one to tell good from bad simply by brief inspection; the result is that the Department buys Spar varnish at 89 cents per gallon, and puts this wretched and worthless stuff on a ship worth perhaps five millions of dollars, while no private shipbuilder would look at a varnish for any such purpose which was worth less than two and a half to three dollars per gallon. That is exactly the way this thing works. There is no part of our public service which stands in greater need of reform than this matter of purchasing supplies. An engineer or architect should regard his employers' or clients' interests as though they were his own; and if he thinks the best results are likely to be obtained by using a particular paint he ought to call for that in his specifications; and the man who acts on that principle can safely leave his reputation to take care of itself.

Some of my friends will probably ask if I have abandoned my belief that the best protection for metal is a baked coating, and if not, why I have not advised its use in specifica-

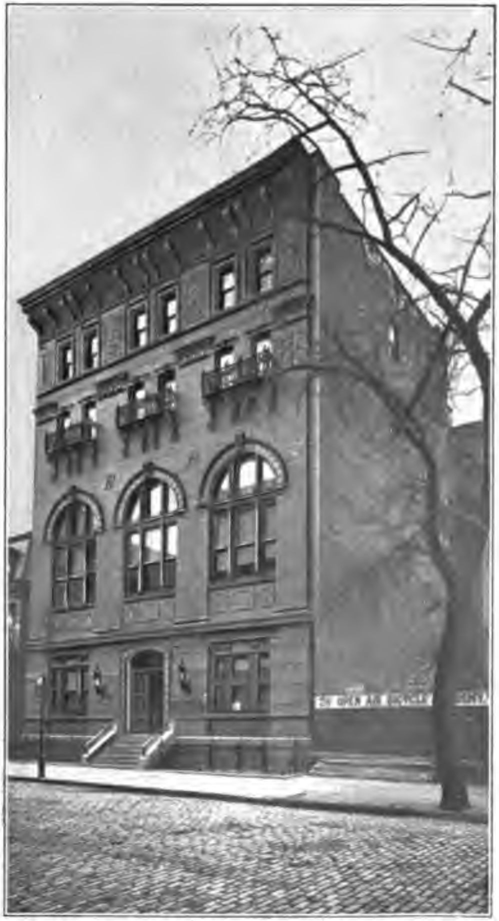
**PRESBYTERIAN BUILDING, 156 FIFTH AVE., NEW YORK CITY.**

James P. Baker, Architect. The wood work of this building is finished with our I. X. L. Varnishes.

Edward Smith & Co., 45 Broadway, New York.

# MEMORANDUM

tions intended to bring about a very high class of work. To this I would say that in the first place I think just as well of the baked coating as I ever did, and that it is being used more every day, with satisfactory results; but I have not advised its use in these specifications because it is so far in advance of any present practice that it would be utterly useless to talk about such a thing. Nothing is advised in these pages which has not actually been applied to bridge work; and if this publication helps to bring about a better average kind of work the writer will be pleased and satisfied.



**YOUNG WOMEN'S CHRISTIAN ASSOCIATION BUILDING,
124TH STREET, NEW YORK CITY.**

W. W. Knowles, Architect, 111 Fifth Avenue. The steel struc
work of this building is protected with our Durable Metal Coating.

Edward Smith & Co., 45 Broadway, New York.

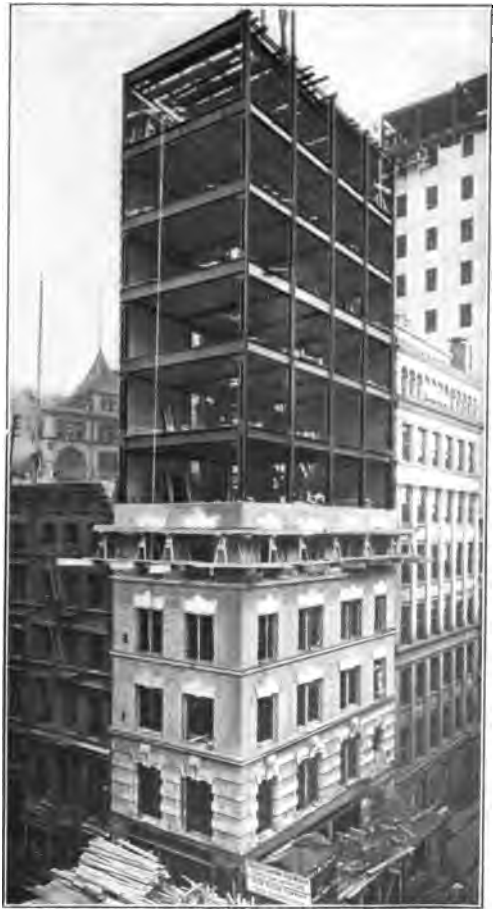
# MEMORANDUM

## II.

## SPECIFICATIONS FOR BEST WORK.

**I. All iron or steel, after being shaped, punched, bored and otherwise made ready for assembling, must be cleaned by the sandblast or other equally efficient means, so as to show, in all parts, the grayish-white color of the metal.**

The cleaning of structural steel work by the use of the sandblast is probably the simplest and most satisfactory way to have it done. The great objection to this, as to all such work, is the cost. Since there are practically no plants for doing such work in bridge shops—in fact there are no plants for cleaning steel by any process—any engineer who decides to call for thorough cleaning must expect to pay an additional sum for such work, which, if the work be of small extent, will be disproportionately great in comparison with the work actually done; but if *the work* be of great extent the incidental cost of the plant will make but a small item in the total cost. Credit is due to the Bureau of Construction and Repair of the U. S. Navy Department, which, acting on the advice of Naval Constructor F. T. Bowles, has installed plants of this character, and the same are in daily use, with most satisfactory results; to Mr. E. P. North, lately consulting engineer to the Department of Public Works of New York City, who made use of this method of cleaning a section of the 155th St. viaduct, with results which are well known; and to Mr. L. L. Buck, who has required that all structural steel for the new East River Bridge shall be cleaned in this way. These are, so far as I know, the first considerable applications of this process to structural steel. It has been objected that this is a patented process; it is therefore in order to observe that the original patent, under which work of great extent was carried on most successfully for fifteen years, was issued to Gen. Benj. G. Tilghman, of Philadelphia, on Oct. 18th, 1870, being No. 108,408, and has therefore expired long ago.



**CUSHMAN BUILDING, COR. MAIDEN LANE AND BROADWAY, NEW YORK CITY.**

Chas. P. H. Gilbert, Architect. The steel frame work of this building is protected with our Durable Metal Coating.

Edward Smith & Co. 45 Broadway, New York.

# MEMORANDUM

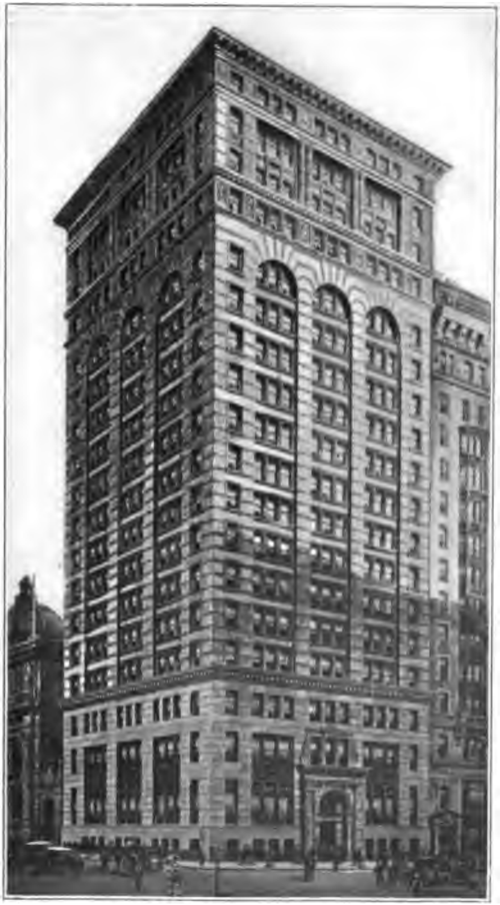
Among the most important claims granted by that patent were the following:

"1. The cutting, boring, dressing, engraving and pulverizing of stone, metal, glass, pottery, wood, and other hard or solid substances by sand used as a projectile, when the requisite velocity has been imparted to it by any suitable means.

"2. The artificial combination of a jet or current of steam, air, water, or other suitable gaseous or liquid medium, with a stream of sand, as a means of giving velocity to the sand when the same is used as a projectile as a means of cutting, boring, dressing," etc., etc.

"7. When a jet or current of steam, air, water, or any other suitable gaseous or liquid medium is employed to give velocity to sand used as a projectile, as a means of cutting, boring, dressing," etc.; "the use of the following devices for introducing the sand into the jet of steam, air, water, etc.: First, the suction produced by the jet of steam, air, water, etc. Second, a strong, close vessel, or sandbox, into which the pressure of the steam, air, water, etc., is introduced, and through which, when desired, a current of it may be made to pass."

It is obvious from the foregoing that there is no existing patent on the process; and while there is some patented apparatus which is preferred by some of the people who use the process, this is equally true of a very large proportion of all machinery in use. The Tilghman apparatus is sold by Ward & Nash, 25 Purchase St., Boston, Mass. The process of cleaning with the sandblast is essentially as follows: Air at a pressure of 20 to 25 lbs. per sq. in. is furnished by any suitable air compressor. If we assume that we will use a discharging nozzle 9-16 in. internal diameter when new, each such nozzle will require 120 cu. ft. of air per minute, measured at atmospheric pressure compressed to show a pressure of 15 lbs. per sq. in. at the nozzle. This is, however, to be regarded as a minimum; for it is advisable to use a somewhat higher ssure, say 20 lbs.; and the nozzle idly wears away until it reaches a



**BANK OF COMMERCE, 31 NASSAU STREET, N. Y.**

James B. Baker, Architect. Interior finished with our Varnishes.
Edward Smith & Co., 45 Broadway, N. Y.

# MEMORANDUM

diameter of ¾ in., at which it will discharge nearly twice as much as when new, so that in practice it is well to provide an air compressor handling 240 cu. ft. of air per minute, and compressing the same to 20 lbs. per sq. in. For four of these nozzles, each connected with a No. 6 Ward & Nash apparatus, an Ingersoll compressor of 24-in. stroke, 22-in. steam and 22¼-in. air cylinder was used; and such a plant ought to be supplied with steam from a 150 H. P. boiler. These latter figures are, of course, rough; but from the number of cubic feet of air used and the pressure any one can compute the rest of the plant.

Into this current of air dry sand is introduced at the rate of about 10 cu. ft. of sand per hour for each such nozzle, or 1 cu. ft. of sand to 1,000 cu. ft. of air. The sand must be artificially dried; some operators use coarsely powdered quartz; this latter can be used five times in succession; and in general the sand may be used until it is broken up into a powder too fine for use. In the plants which the writer has inspected the sand and air are carried to the nozzle through a heavy rubber hose about 2½ in. diameter; this is not worn away by the current as a metal pipe would be; but it is necessary that the air should not be hot, as this would rapidly injure the hose. The nozzles are short pieces of chilled iron pipe, and have to be renewed at frequent intervals. From data furnished me by Naval Constructor Bowles I find that the cost of cleaning the bottom of a ship in dry dock amounted to about 4 cents per sq. ft.; but this was done with an experimental plant, and the method of drying the sand, which was used only once, was costly, and the cost would certainly have been reduced to 3 cents per sq. ft. if a permanent plant had been in use; since the installation of a permanent plant no work has been done of sufficient magnitude to give figures. This was an exceedingly rusty surface; but with this same experimental plant the mill scale was removed from 3,155 sq. ft. of surface of steel plates at a cost of $17.60, or about ½ cent per sq. ft.; and at the rate of 4¾ sq. ft. per minute per nozzle.

**WATER TOWER, READING, MASS.**

Height, 100 ft.; diameter, 30 ft. This water tower is coated with our Durable Metal Coating.

Edward Smith & Co., 45 Broadway, New York.

# MEMORANDUM

It may be well to add that in all the work referred to, which was practically field work, being carried on out of doors and with a somewhat portable plant, the labor amounted to one man to hold each nozzle, one man to attend to each two sandboxes, and one man to clean up and carry sand for each four nozzles. The supply of compressed air is an expense of a different sort, as is also, in field work, the matter of staging, etc.; but all are included in the prices given. It seems reasonable to suppose that where many pieces of metal of the same general character are to be treated in a shop fitted up for the purpose, contrivances may be introduced which will do away with a considerable part of the labor.

Some further information in regard to cleaning the 155th St. viaduct may be found in the Engineering News of Sept. 23d, 1897, or the Engineering Record of Sept. 25th, 1897.

Iron and steel may also be cleaned by pickling in acid and the subsequent removal of the latter. This may be done in the following manner: The pieces of metal which have been made ready for assembling are immersed in hot dilute sulphuric acid having a strength of 25 to 28 per cent. Some use acid of 20 per cent. It is kept in this until the whole surface is free from rust and scale; this will take from 6 to 12 minutes. If the pieces of metal are somewhat rusty, so that rust has started underneath the scale, the shorter time will be found sufficient; but if it consists of plates covered with closely adherent blue or iridescent rolled scale, the longer time will be necessary, since this scale is itself insoluble in acid, and is removed by the latter penetrating the innumerable minute cracks in the scale and attacking the iron underneath, thus mechanically throwing off the scale. If, on the other hand, the iron is uniformly rusty, this coating of hydrated oxide readily dissolves in acid; and in fact a weaker acid of 10 per cent. to 12 per cent. might be used, although the stronger acid is quite safe, but will require a shorter time. It has been suggested that it is desirable to previously clean the metal with

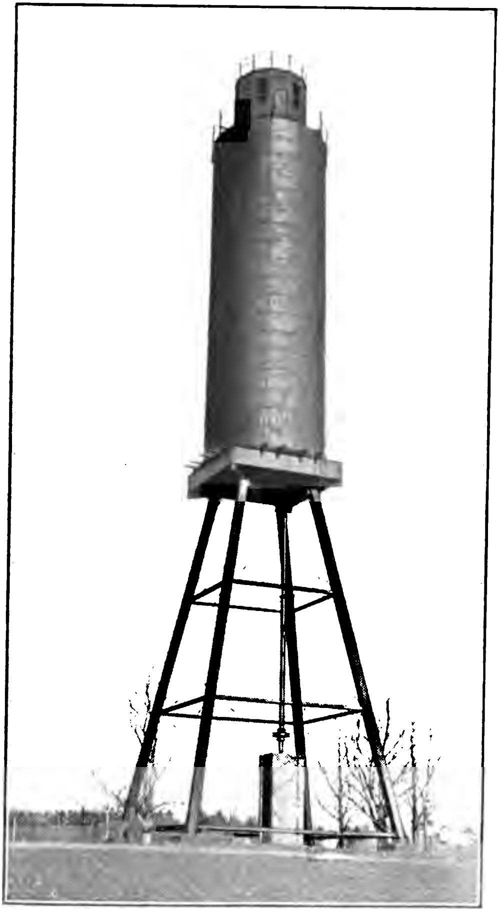
# MEMORANDUM

caustic alkali from all grease, etc.; but if acid of the above strength is used and kept as hot as possible this will not be necessary. As soon as the acid has reached the iron in all parts of the surface the metal is taken out and washed by jets of water discharged against it under high pressure, not less than 100 lbs. per sq. in., and much better if double that. In this way the acid may be thoroughly removed.

In Germany it is said to be customary to use acid of 9 or 10 per cent. cold, and the metal is left in it five hours. This makes a much larger plant necessary and has no advantages.

If it is attempted to remove the acid by soaking the metal in still water the following difficulty is encountered: the iron becomes immediately coated with a gummy or colloidal substance, very difficult to remove. What this is, is not known to the writer; but it is well known that there are a number of insoluble or difficultly soluble compounds of iron with sulphuric acid, and it is probable that some of these are precipitated on the surface of the iron when water removes the excess of acid; but if a jet of water is used the mechanical effect is to remove the adherent ferrous sulphate at the same instant, leaving a clean metallic surface. It is also possible that if the acid contains arsenic, as is the case with much of the acid made from pyrites, this may also be precipitated on the surface; in fact it is sure to be, and acid free from arsenic should always be used for this purpose, and as a matter of practice it is insisted on by many.

It is often difficult and sometimes impracticable to pickle steel high in carbon, and cast iron containing graphitic carbon, on account of the deposit of a film of carbon, like stove blacking, on the surface. Muriatic (chlorhydric) acid has been used instead of sulphuric; but it is not well suited for the purpose, being much more expensive and difficult to remove. It also forms a gummy coating on the iron, worse than that with sulphuric; and in the subsequent alkaline treatment it must be removed by caustic soda instead of lime, or,



WATER TOWER, PRINCETON, N. J.

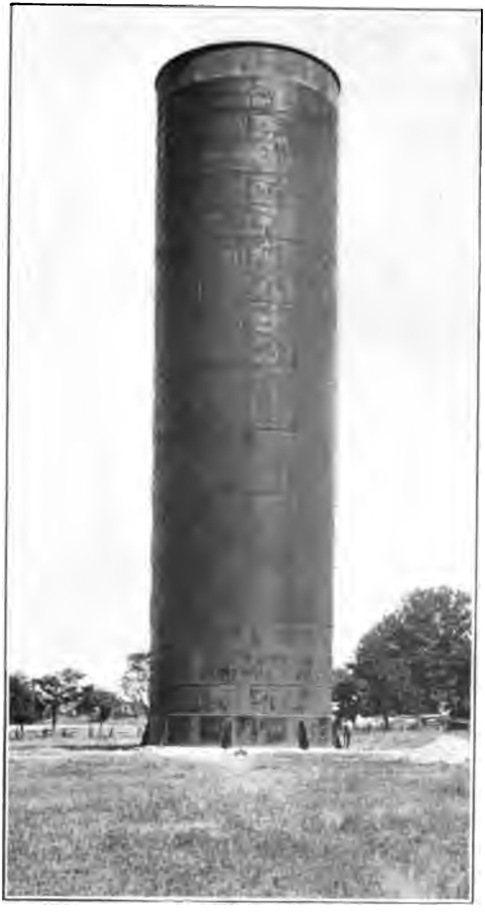
This stands on a trestle 60 ft. high; height, 60 ft.; diameter, 20 ft capacity, 142,000 gallons. J. J. R. Croes, C. E., Designer. The inside this tank is coated with our Durable Metal Coating.

# MEMORANDUM

better, by a solution of sulphate of zinc.

After the iron has been freed from sulphuric acid in the manner just described, it is put in a bath of lime-water or milk of lime, boiling hot (it is very important that it should be hot), and left there long enough to reach the temperature of the liquid. It is then removed to an oven and dried, after which the lime is brushed off. If desired the lime may be removed by washing before putting in the oven; in this case it will be found that the surface, which is perfectly clean and bright, rusts very easily and quickly; whereas if the lime is removed by drying and brushing, the surface is much less likely to rust, although even then it rusts easily and should be painted immediately.

For most of the foregoing information relating to pickling I am indebted to Mr. E. G. Spilsbury, who has had extensive experience in this work both in Europe and the United States, and has applied the process to structural steel (bridge) work, as well as to wire and wire rods. Mr. Spilsbury estimates the total expense of pickling and cleaning steel for bridge work in a modern and well-arranged plant at about 25 cents per ton. As to the time when the cleaning is to be done, it may be said that the metal may be cleaned before it reaches the shop at all. This is in one respect a simpler method, as requiring less handling. It is obviously impracticable to do the work of cleaning either by the sandblast or acid in the shop itself, and the method specified involves the removal of the pieces from the shop and bringing them back. This extra labor is variously estimated by shop owners and managers who have been consulted at from 50 cents to $2 per ton; doubtless some have much better facilities than others; and there will also be a difference of cost in handling light or heavy work. To offset this extra charge, which would be, if we average the estimates of the persons consulted, about $1 per ton, we save the application of a shop coat of oil. The metal will remain in the shop not less than a week, as an average; and it is necessary that



**STAND PIPE, CAMDEN, N. J.**

**Height, 110 ft.; diameter, 30 ft. L. E. Farnham, City Engineer. This stand pipe is coated with our Durable Metal Coating.**

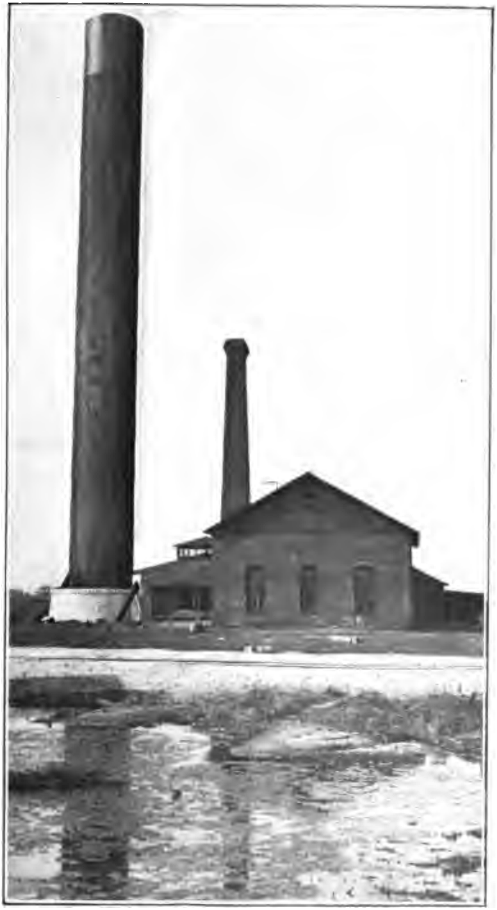
**Edward Smith & Co., 45 Broadway, New York.**

# MEMORANDUM

it should be protected during that time from rust. The shop men all agree that it will not do to paint it at that time, and that an oil coat is the only thing which is practicable. It is quite well known that raw linseed oil is much more durable than boiled oil, and if we apply a coat of boiled oil, which will dry in about 24 hours, we are in the irrational position of having taken great care to secure a perfect surface, and then applied a foundation coat of inferior material.

So we are brought to the necessity of using raw oil; and this will require about a week to dry, during which time the metal certainly ought to be kept under cover. The expense of this coat of oil, applied in this manner, is variously estimated at from 50 cents to $1 per ton; and it is pretty generally agreed that the result of this method of doing the work will not be as good as the specified method. For it must be remembered that dry linseed oil is not a hard substance like a varnish film, but is a gummy substance, which during the shop handling will get dirty with solid matter and with machine oil, which cannot be removed and must subsequently be painted over; while, if we wait until the shop work is done, all but the assembling, we get the surfaces perfectly clean, and can then apply our shop coat of paint, which will be dry so it may be handled in 48 hours; and then when we rivet it up we can apply a second coat of fresh paint to the surfaces to be riveted together, which are by far the most important to preserve, as it is in these and other crevices that most of the dangerous rusting is likely to occur, especially if the work is properly cared for in the way of maintenance. More will hereafter be said in regard to the matter of shop coat of oil.

II. Immediately after being so cleaned, and before any discoloration due to rusting has begun, the material shall be carefully inspected, and upon the approval of the inspector, shall receive one full coat of Durable Metal Coating made by Edward Smith & Co., of 45 Broadway, New York City; except planed and turned sur-



**STAND PIPE, ATLANTIC CITY, N. J.**

Height, 140 ft., diameter, 15 ft., capacity, 185,000 gallons. Designed and built by Tippett & Wood, Phillipsburg, N. J. This stand pipe is coated on the inside and on the top rings on the outside with our Durable Metal Coating.

Edward Smith & Co., 45 Broadway, New York.

# MEMORANDUM

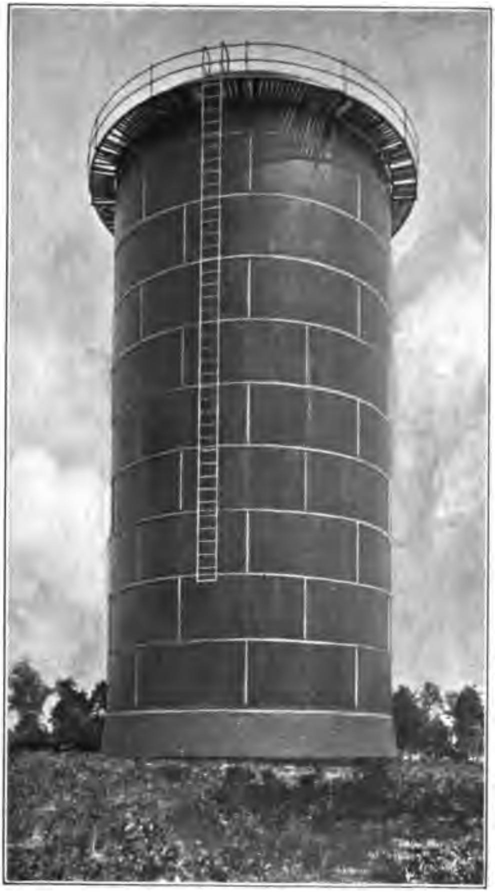
**faces, which shall be coated with Vacuum Flushing Oil and shall be kept so coated until they are erected in place.**

In order to carry this section into effect it will be necessary to paint the work at once, within one or two hours of the time when it is cleaned. If the metal has been pickled it will therefore be hot from the oven; it is then in the best condition, for paint spreads better and penetrates crevices when the metal is hot, and there is practically no air film on the metal to be displaced. It is the opinion of many engineers that the best results would be obtained by immersing the pieces of iron or steel in a tank of hot paint, at a temperature of about 175° F., and leaving it there fifteen minutes or more. By doing so all the surface would be reached, and it is probable that such a course would show great economy of labor, which is the most important item of cost in painting. It must be remembered, whatever method is adopted, that the most important matter about this whole work is to get the best possible foundation coat attached as securely as possible to the metal; the subsequent cost of maintenance will be greatly reduced if this is effectively done.

This is the crucial point of the whole work of painting.

III. The metal shall not be exposed to the weather nor taken to the shop until in the opinion of the inspector the paint is sufficiently dry. At no time after the preliminary cleaning shall the pieces of iron or steel be laid on the ground, but shall be laid on skids or trestles, and in all handling and loading and unloading of the same care shall be taken to avoid scraping off the preservative coating; and in transportation care shall be taken to avoid nesting the pieces except with packing material between them.

It is not expected that the work will be held in the paint shop until the paint is thoroughly dry, but only until it has got its initial set throughout; but of this the inspector is to be the



**STANDPIPE AT PALATKA, FLA.**

**Height 60 ft., diameter 25 ft., capacity 183,000 gals. Designed by Wm. Wheeler, 89 State Street, Boston. Painted with our Durable Metal Coating.**

**Edward Smith & Co., 45 Broadway, N. Y.**

# MEMORANDUM

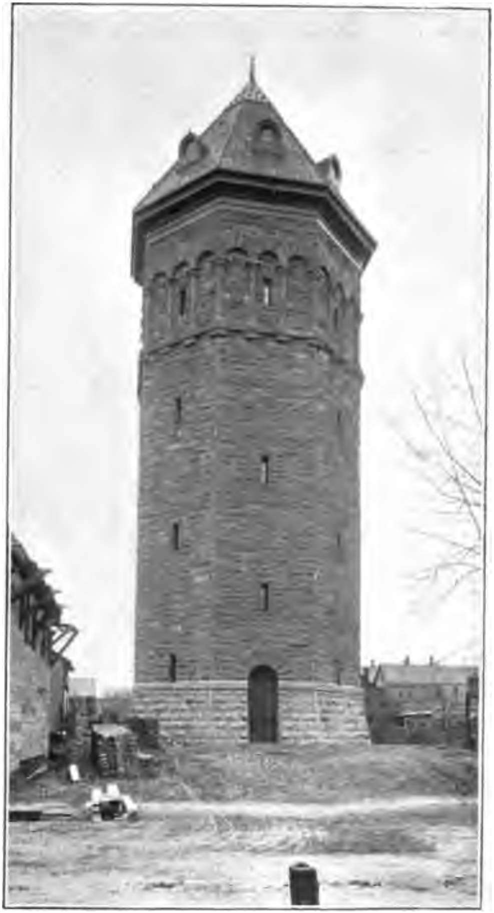
judge. It is probable that it will take two days, sometimes three.

IV. After being taken back to the shop all surfaces which are to be there riveted or bolted together are to be cleaned, if necessary, and painted on each such surface with a second coat of said Durable Metal Coating; only such parts of surfaces as are to be thus brought in contact are to be so treated. After riveting, all small cavities which will hereafter be inaccessible shall be filled with a thick paste of litharge and glycerine, freshly prepared, or with a melted mixture of three or four parts of gilsonite or other equally hard asphaltum, and one part of linseed oil.

The use of litharge and glycerine for filling crevices is founded on the very old and well-approved practice of using such a composition, which forms a quick-setting cement, for cementing the iron corners to the glass sides of aquaria. It has no action on iron, even in the presence of water, is quite insoluble and waterproof, and has considerable elasticity. The asphaltum and oil mixture is perfectly non-porous, and very elastic and durable. Either is believed to be better than the use of hydraulic cement.

**V. After erection the work shall be carefully inspected, and if there are any rusty spots these shall be thoroughly cleaned and all such places and also places where the paint has been rubbed off shall receive a coat of Edward Smith & Co.'s Durable Metal Coating; and all exposed edges and angles shall receive an extra striping coat of the same, covering the edge and the adjacent surface one or two inches from the edge on each side; all rivet and bolt heads and nuts shall also receive an extra coat; after this has become dry the whole surface, having previously been thoroughly cleaned from dirt, shall receive another full coat of said Durable Metal Coating.**

When paint begins to dry there is at first a sort of skin formed on the surface, which contracts, and on rounded



**WATER TOWER, SCHENECTADY, N. Y.**

**Height, 147 ft. Built by the Stanwix Engineering Co., Rome, N. Y. Tank protected with our Durable Metal Coating.**

**Edward Smith & Co., 45 Broadway, New York.**

# MEMORANDUM

surfaces like rivet heads, and on angles and edges, seems to press away the liquid paint beneath, so that on such surfaces there is less than the normal amount. The same tendency to contract also exists on flat surfaces, but in this case it is a balanced tension and produces no effect. There is besides the action of the painter's brush, which presses harder on such places and draws off the paint; but that this is not the main cause is shown by the fact that pipe sections and other things which have been coated by dipping exhibit the same appearance. In making paint tests, it is necessary to leave out of account a strip about an inch wide along the edges of the plate, unless that portion has received an extra coat; and the fact is well known to inspectors that such surfaces are always thinly coated. The extra striping coat is therefore necessary if we are to have two full coats or their equivalent over the whole surface; and it is the more important because these portions are more exposed than the flat surfaces.

VI. In no case shall a second or third coat of paint be applied until the previous one is entirely dry.

VII. During erection any small cavities which will hereafter be inaccessible shall be filled as provided in Section IV.

VIII. After receiving the second coat of Durable Metal Coating, and after the same has become quite dry, the whole structure shall receive two coats of such paint as may be designated and approved by the engineer, the pigment in such paint to consist of two parts by weight of white lead and one part of white zinc, tinted to a designated shade; and the vehicle to be a varnish composed of only hard varnish resins and pure linseed oil and turpentine, the oil being in the proportion of not less than two parts by weight of oil to one part by weight of the aforesaid resin weighed before melting; and the product to be free from common rosin, benzine and mineral oil products; and samples of the paint which the contractor proposes to use for this work shall be ob-

**WATER TOWER AT PAINESVILLE, O.**

Height 72 ft., diameter 20 ft., capacity 169,000 gals. Painted with our Durable Metal Coating.

Edward Smith & Co., 45 Broadway, N. Y.

# MEMORANDUM

**tained not less than one hundred days in advance and submitted to the engineer for examination and approval, and no such paint shall be used unless approved by him, and his rejection of any paint shall be final; and when such sample has been approved, the contractor must use the paint made by the same manufacturer who made the sample, and the paint must be, when used, exactly the same in every respect as the tested sample and must not be thinned down or adulterated or changed in any way whatever; and it shall be used subject to all the conditions mentioned in the following section.**

Section VIII is intended exclusively for structures which must be painted a light color. The only pigments which can be used as a base for light-colored paints are white lead and white zinc; neither of these is regarded as very durable, but their use is absolutely unavoidable. A mixture of the two is regarded as better in many ways than either alone. They may be mixed with good results in any proportion from two parts of lead to one of zinc, to one part of lead to two of zinc; the former proportion is a very common one. They are liable to be adulterated with sulphate of baryta, carbonate of lime (whiting), china clay and ground feldspar. None of these has any value, and paint containing any of them should be rejected. White lead paint has a tendency to show a granular surface which will brush off; it "chalks," to use the painter's word; zinc tends to come off in flakes. On this account it is better to use a varnish as a vehicle or binder rather than oil, as the former has more hardness and tenacity; moreover, a varnish paint, if made of good materials, is more impenetrable to air and water, and therefore more desirable. But it is important that the varnish should be suited to the purposes. As a rule, the larger the proportion of oil to resin the more elastic and durable is the varnish; but a point is reached when the resin appears to be saturated with oil, beyond which any more l has a deleterious effect. The exact

WATER TANKS AT PITTSBURGH, PA.

Each 40 x 25 ft., capacity 210,000 gals. each. A. B. Shepard, Engineer of Water Supply. One tank coated in 1895, the other in 1897, with our Durable Metal Coating. Edward Smith & Co., 45 Broadway, N. Y.

# MEMORANDUM

proportions vary with the kind of resin, and also depend on some other conditions; but in general the most durable varnishes contain from two to two and a half times as much oil as resin, the latter being weighed before melting, during which process it loses about one-fourth its weight. Such a paint will not be required to be perfectly white, being usually tinted to some designated color, and can be sold in large quantities at a price probably not more than 30 or 40 per cent. more than a straight lead and oil paint will cost; it will be found much more economical. As to testing such a paint, it is absolutely necessary to have a reasonable time, and 100 days is little enough. It would be better to have more. Of course, if it is admissible to leave the structure black this section will be omitted; but in that case, for really high-class work such as these specifications contemplate, a third coat of the protective coating will be advisable. It is expected that the coating of white or light-colored paint will require to be renewed from time to time, while the durable metal coating is depended on for permanent protection.

IX. All paint and Durable Metal Coating used for this work shall be purchased directly from the manufacturer or his authorized agent, and each shipment shall be accompanied by a signed certificate from the manufacturer or such agent, stating that he has, at that time, shipped a specified amount of the specified paint or Durable Metal Coating; and all paint and Durable Metal Coating shall be brought on to the premises where they are to be used in the manufacturers' sealed packages, which shall be opened in the presence of the inspector, who may then, and at any subsequent time, take samples for examination or analysis; and in case any analysis made by direction of the chief engineer shows impurity, adulteration or substitution in these specified materials, the contractor shall pay all the costs of such analysis, and shall moreover thoroughly clean off all metal coated with such impure or unauthorized material and shall repaint it to the

**STAND PIPE, GRAND RAPIDS, MICH.**

Height, 75 ft.; diameter, 30 ft.; capacity, 397,000 gallons. This stand pipe is coated with our Durable Metal Coating.

Edward Smith & Co., 45 Broadway, New York.

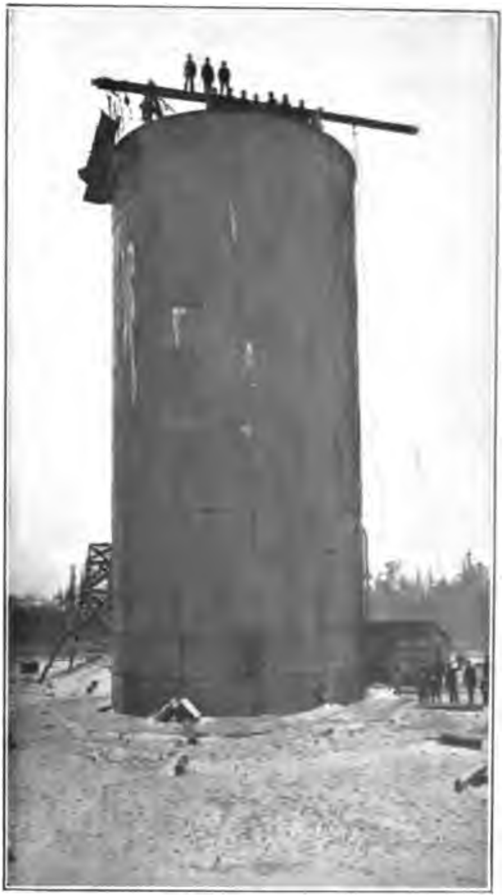
# MEMORANDUM

satisfaction of the inspector. And the contractor shall, upon demand, exhibit to the engineer or inspector the bills from the manufacturers or their agents, showing the amount of paint and Durable Metal Coating purchased, and also the certificates spoken of in this section; and neither the paint nor the Durable Metal Coating shall be thinned with anything whatsoever, nor shall any turpentine or benzine be allowed upon the premises for any purpose, except by permission of the inspector and in such quantity as he may allow.

X. The inspector shall be notified when any painting, either with Durable Metal Coating or other material, is to be done, and no such work is to be done until the inspector has approved the surface to which it is to be applied; and the contractor shall furnish all facilities for inspection and for necessary marking by the inspector, and all materials, such as paint, brushes, etc., for such marking. No such inspection or marking shall be done except by the engineer or his authorized inspector.

**XI. In no case shall any paint be applied out of doors in freezing, rainy or misty weather, and all surfaces to which paint is applied must be at the time dry and clean; and all work must be done in a thorough, neat and workmanlike manner. If it is necessary, in cool weather, to thin the paint, this may be done only by heating it; and this may be required by the inspector.**

The practice of heating paint before it is applied has been followed for a considerable time by some of the best engineers. It is sometimes done by keeping several tin pails of paint in a hot water tank, kept hot by exhaust steam; or where there is no steam plant it is heated directly over a small oil stove or other source of heat. If heated from 125° to 150°, which is perfectly safe if the paint contains no benzine—in fact it may safely be heated as hot as boiling water will make
't flows much more freely, and
rates the crevices of the work
better. It is indeed likely to



**WATER TOWER, CALUMET, MICH.**

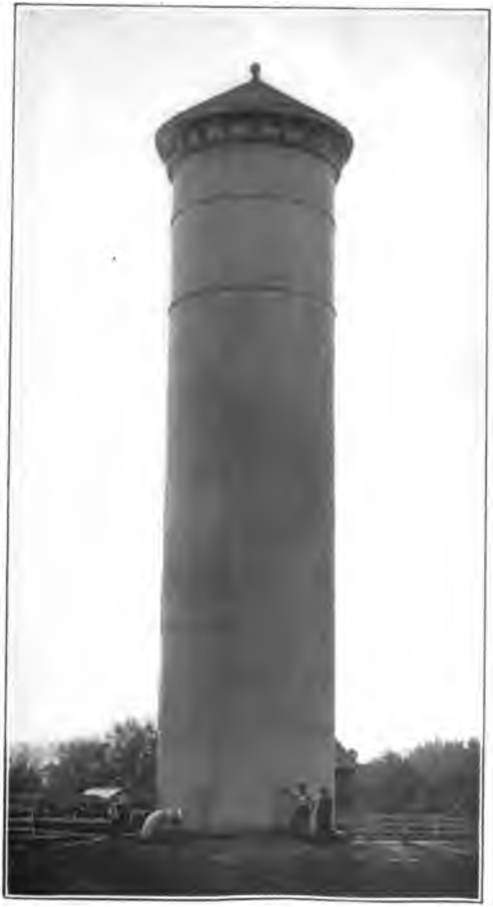
Designed by E. D. Leavitt, C. E., Boston, Mass. Capacity, 520,000 gallons. Built and maintained by the Calumet & Hecla Copper Co. This water tower is coated with our Durable Metal Coating.

Edward Smith & Co., 45 Broadway, New York.

# MEMORANDUM,

make a thin coat, which is objectionable; but the advantages outweigh the disadvantages.

**XII. The foregoing specifications shall be accepted and carried out faithfully in every particular and shall not be construed according to any prevalent practice not in full accord therewith.**



**WATER TOWER, LE SUEUR, MINN.**

Height, 75 ft.; diameter, 18 ft.; capacity, 182,000 gallons. Designed by C. F. Loweth, St. Paul. Minn. This water tower is coated with our Durable Metal Coating.

Edward Smith & Co., 45 Broadway, New York.

# MEMORANDUM

## III.

## SPECIFICATIONS FOR ORDINARY WORK.

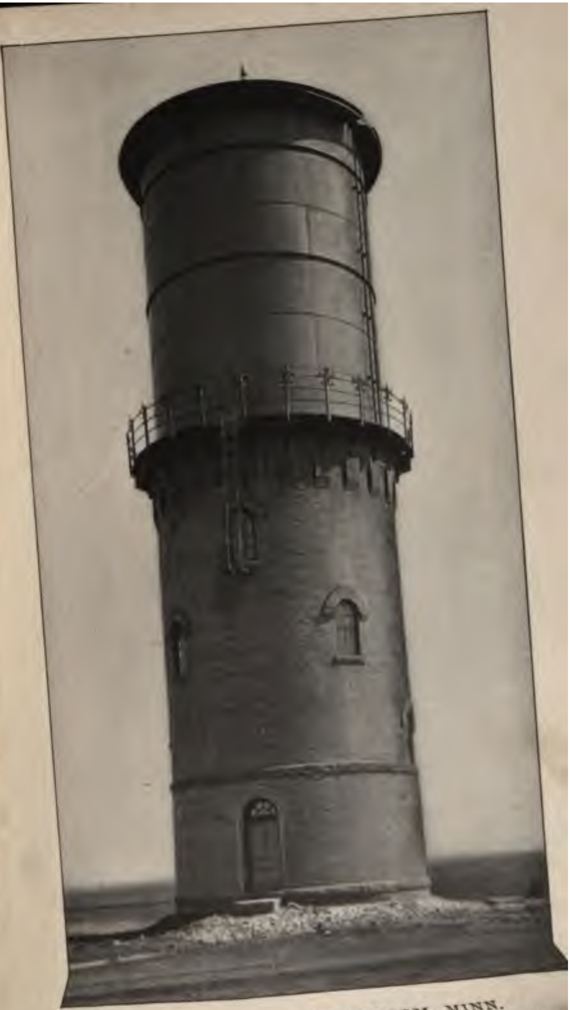
**I. Shortly before riveting, all such parts of surfaces as are to be brought permanently into contact shall be thoroughly cleaned from dirt and rust, and from all scale which does not perfectly adhere to the metal, by the use of scrapers, chisels and wire brushes; the latter alone shall not be considered sufficient. Each such surface shall then receive one full coat of Durable Metal Coating, made by Edward Smith & Co., of 45 Broadway, New York.**

The wire brush is an efficient means of getting rid of loose scale and dirt; but it is practically worthless for removing thick rust or anything which adheres closely. Much of such material may be removed by steel scrapers; but deeply corroded spots should be thoroughly cleaned out with a chisel, and then well brushed.

These crevices are hereafter to be inaccessible; and they are subject to the most dangerous corrosion, because rusting at such places impairs not only the strength, but also the stiffness, of the structure—a matter of much importance. These joints therefore deserve more care than any other part.

II. Shop-marks shall be compact and shall not cover more surface than the inspector directs, the intent being to have the surface occupied by such shop-marks as small as possible.

III. After assembling, the whole of the metal surfaces shall be thoroughly cleaned in the manner described in the first section, and shall then receive one full coat of said Durable Metal Coating, except planed and turned surfaces and shop-marks; and all planed and turned surfaces shall be coated with Vacuum Flushing Oil and shall be kept so coated until they are erected in place; and all small cavities which will hereafter be inaccessible shall be filled with a thick paste of



WATER TOWER AT WINDOM, MINN.

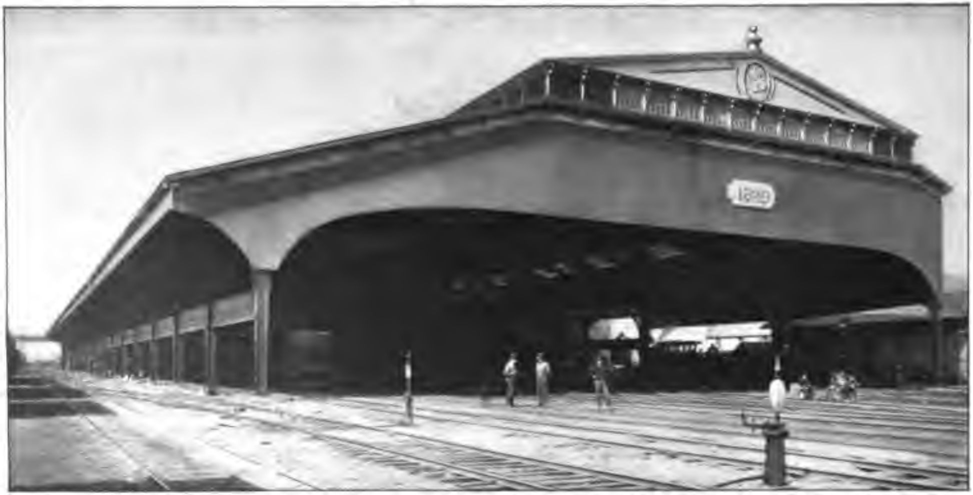
*Brick tower* 50 ft. high; tank 25 x 35 ft.; capacity, 135,000 gallons *coated with our* Durable Metal Coating. C. F. Loweth, Designer, *Minn.*

Edward Smith & Co., 45 Broadway, New York.

# MEMORANDUM

litharge and glycerine, freshly prepared, or with a melted mixture of three or four parts of gilsonite or other equally hard asphaltum and one part of linseed oil.

Many engineers are in the habit of specifying a coat of either raw or boiled linseed oil at the shop, instead of a shop coat of paint. The advantages claimed for a shop coat of oil are, first, it facilitates inspection, as the oil is transparent; second, it makes an extra coat; third, the paint is likely to be more carefully applied if used at the place of erection. Doubtless these considerations are entitled to some weight; but many of the best engineers practice shop painting, which indicates that inspection can be carried on efficiently after the first coat of paint has been applied; and at many shops very excellent painting is done, while the contractor who does the erecting is, so far as my observation goes, extremely indifferent to the paint question. When it comes to the matter of architectural iron work, we might as well give up the idea of having two coats of paint applied during erection; it takes too much time, and delay is a word not in the contractor's vocabulary when paint is concerned. But another and more important matter is this: If we apply a coat of raw linseed oil we must allow about a week for it to dry, and it certainly ought to be kept all this time under cover, for fresh oil will wash off to a considerable extent if exposed to rain. If, on the other hand, we use boiled oil, we will have it dry in 24 hours; but boiled oil is much less durable than raw, and as this is the foundation coat it is of the highest importance that it should be as durable as possible; and it is much more difficult to detect impurities in boiled than in raw oil. Further, there has grown up among the steel men a belief that the shop coat of oil is only for protection during shipment, and with this has come the practice of applying a cheap and worse than worthless substitute for linseed oil, mposed chiefly of mineral oil, some- es further adulterated with rosin. s oil will penetrate the paint which



**UNION DEPOT TRAIN SHED, ST. PAUL, MINN.**

**Extension painted with our Durable Metal Coating. Designed by C. F. Loweth, St. Paul.**
**Edward Smith & Co., 45 Broadway, New York.**

# MEMORANDUM

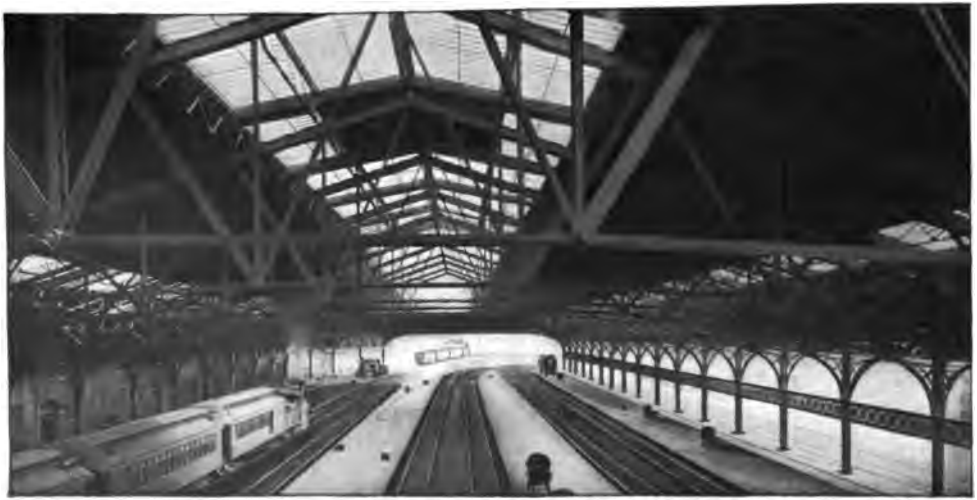
is put over it, and as the film of oil is about half as thick as the coat of paint it is equivalent to thinning the latter with half its volume of very deleterious and injurious matter. It is then a question not how much good, but how little harm does the shop coat of oil do. I have no doubt that often a good paint has been a failure because of the shop coat of oil. And if the shop manager cannot be trusted to apply a shop coat of paint I would certainly be afraid of the oil he would use.

It is worthy of note that there is good authority for the following procedure in bridge work: A shop coat of the best raw linseed oil is applied, and the work is then erected and allowed to stand one to six months, until the oil is supposed to have thoroughly penetrated and with the aid of the weather loosened the scale.

The whole surface is then very thoroughly cleaned (as in Section I) and given two coats of paint. It is claimed that by this means the mill scale is well removed, while rusting has been avoided. There are reasons for thinking this good practice, but it involves watchful care and thorough work.

If it is determined to use oil, the following specification is recommended:

The oil used for this purpose shall be raw linseed oil of the best quality; shall be permanently clear and settled by aging or storage for not less than 30 days; free from rosin as well as mineral, fish and cottonseed oils, or any other impurities; shall contain no benzine, turpentine or other solvent, nor any lead or manganese compounds; it shall be purchased directly from some reputable manufacturer of linseed oil, and each shipment shall be accompanied by a signed statement from the manufacturer saying that he has, at that time, shipped a specified amount of pure raw linseed oil of the best quality; and it shall be brought on the premises where it is to be used in the manufacturer's sealed packages, which shall be opened in the presence of the inspector, who may then and at any subsequent me take samples for examination analysis; and in case any analy-



**UNION DEPOT TRAIN SHED, ST. PAUL, MINN.**

Extension painted with our Durable Metal Coating. Designed by C. F. Loweth, St. Paul, 1897. Edward Smith & Co., 45 Broadway, New York.

# MEMORANDUM

sis made by direction of the chief engineer shows impurity, adulteration or substitution in this material, the contractor shall pay all the costs of such analysis, and shall moreover thoroughly clean off all metal coated with such impure or unauthorized oil and recoat it to the satisfaction of the inspector. And the contractor shall upon demand exhibit to the engineer or the authorized inspector the bills and statements from the manufacturer showing the amounts of oil purchased.

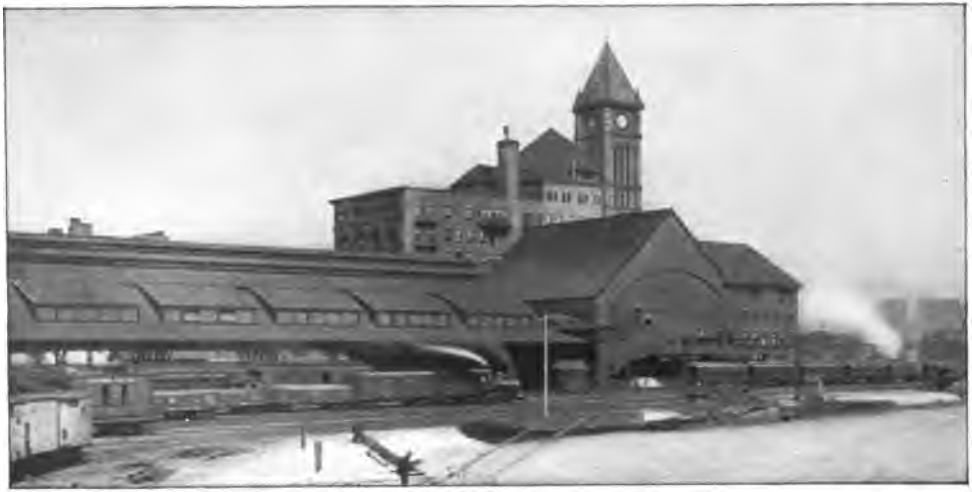
In case boiled oil is to be used the word "boiled" would be substituted for "raw" in the foregoing, and omit "nor any lead or manganese compounds."

But the writer of this is of the opinion that a shop coat of oil is in most cases a useless expense (which might far better be applied to a striping coat), and in a large proportion of cases a positive and great injury. Vacuum flushing oil is a very heavy mineral oil, about as heavy as an oil for wagon axles, and has been successfully used for a long time. It appears to be much better than the usual mixture of white lead and tallow, which is not very satisfactory. It is not expensive.

"All *small* cavities." It is not proposed, for example, to fill hollow columns in this way. Large cavities which are liable to be wet should be drained; but this is not a matter of painting.

**IV. The metal shall not be exposed to the weather nor loaded for shipment until in the opinion of the inspector the paint is sufficiently dry. At no time after the application of the first coat of paint shall the pieces of iron or steel be laid on the ground, but shall be laid on skids or trestles; and in all handling and loading or unloading of the same care shall be taken to avoid scraping off the preservative coating; and in transportation care shall be taken to avoid nesting the pieces except with packing material between them.**

This section calls for shop painting be done under cover. This is prob- 'y the most radical reform called for these specifications. Few shops



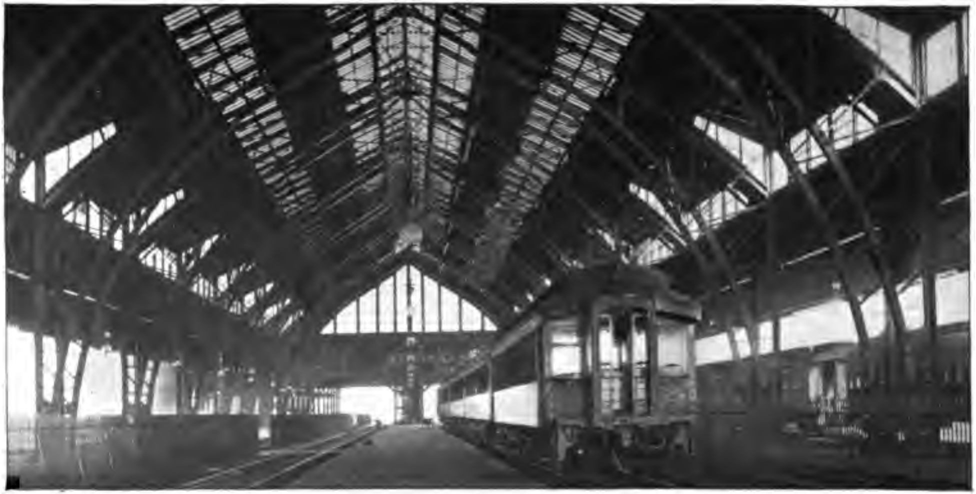
ILLINOIS CENTRAL R. R. DEPOT, CHICAGO.
H. W. Parkhurst, Bridge Engineer. Train shed 670 feet by 140 feet, painted inside with Durable Metal Coating from Edward Smith & Co., 45 Broadway, New York.

# MEMORANDUM

have a paint shop where such work may be done; but while no serious objection can be raised to painting out of doors in dry, warm weather, it must be remembered that this kind of work is going on all the year round, and that during a large part of the time the weather is such that it is impossible to do good work outside. It seems to the writer that if this single reform can be enforced, as it is in all other kinds of painting, a great advance will be made in the matter of preserving steel from corrosion.

Incidentally it has the effect of making the painting a distinct step in the shop work, and recognizing paint as proper engineering material. The rest of the section is of the same tenor, and will be found difficult to enforce, not because it involves any hardship or much expense to the contractor, but because steel is handled in a slovenly and careless manner, being usually thrown off wagons or cars into the mud; and inspectors have really very great difficulty to get the mud cleaned off, or even to have a pretense made of cleaning it off, before the second coat of paint is applied. The reform needed is a change of the spirit in which the work is done, and must lead to a recognition by all, from the owner to the humblest laborer, of the fact that steel is a perishable material, the preservation of which is a matter of serious and constant importance.

V. After erection the work shall be carefully inspected, and if there are any rusty spots these shall be thoroughly cleaned, and all such places and also all places where the paint has been rubbed off shall receive a coat of Edward Smith & Co.'s Durable Metal Coating; and all exposed edges and angles shall receive an extra striping coat of the same, covering the edge and the adjacent surface one or two inches from the edge on each side; all rivet and bolt heads and nuts shall also receive an extra coat; after this has become dry, the whole surface, having previously been thoroughly cleaned from dirt, shall receive another full coat of said Durable Metal Coating.



TRAIN SHED, CHICAGO DEPOT, ILLINOIS CENTRAL R. R., 670 FEET BY 140 FEET.

Parkhurst, Bridge Engineer. This train shed painted inside with Durable Metal Coating from Edward Smith & Co., 45 Broadway, New York.

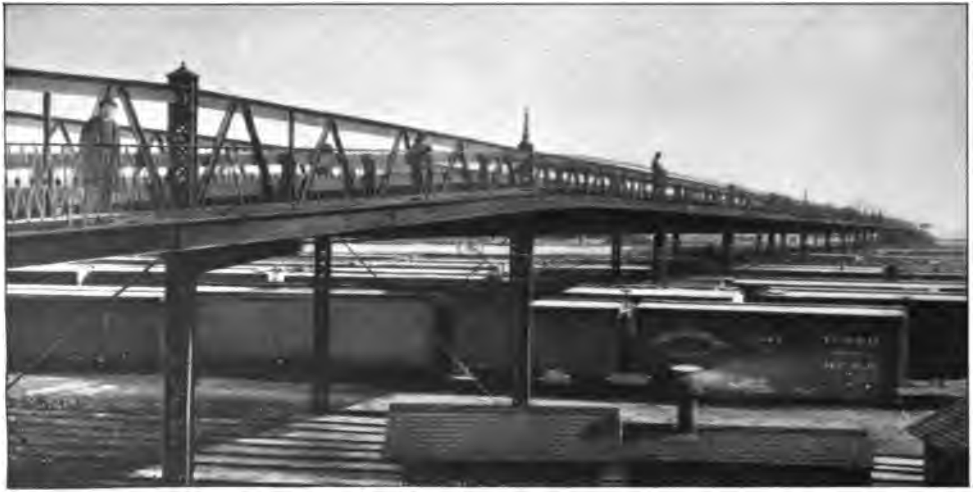
# MEMORANDUM

**VI. In no case shall a second or third coat of paint be applied until the previous one is entirely dry.**

It is proper at this point to call attention to the fact that some engineers specify that successive coats of paint shall differ in color; some advise this on the ground that it makes it easier for the workmen to see if they are missing any places, and anything which makes painting easier is likely to be advantageous; others say it facilitates inspection, and enables the engineer to find out for himself if the required number of coats has been applied. On the other hand, some say there is no difficulty in distinguishing fresh paint from that a day or two old—that, in fact, any inspection worthy of the name will determine whether the work is properly done without regard to this, while competent inspection of bridges can not be done from the platform of a railroad car. Some of the most experienced and careful engineers specify paints of different colors for different coats, but others of equal standing do not approve of it; as a result of extended personal inquiry I am satisfied that a great majority belong to the latter class, and as I myself hold this opinion I have not specified such difference in colors, but only call attention to the matter, so that those who wish may insert an article to that effect.

VII. During erection any small cavities which will hereafter be inaccessible shall be filled as provided in Section III.

VIII. All Durable Metal Coating used for this work shall be purchased directly from the manufacturer or his authorized agent, and each shipment shall be accompanied by a signed certificate from the manufacturer or such agent, stating that he has, at that time, shipped a specified amount of the Durable Metal Coating; and all Durable Metal Coating shall be brought on to the premises where it is to be used in the manufacturers' sealed packages, which shall be opened in the presence of the inspector, who may then, and at any subsequent



**RANDOLPH STREET VIADUCT, CHICAGO, ILLINOIS CENTRAL R. R., LENGTH 1542 FEET.**
H. W. Parkhurst, Bridge Engineer. This has two coats of our Durable Metal Coating. Edward Smith & Co., 45 Broadway, New York.

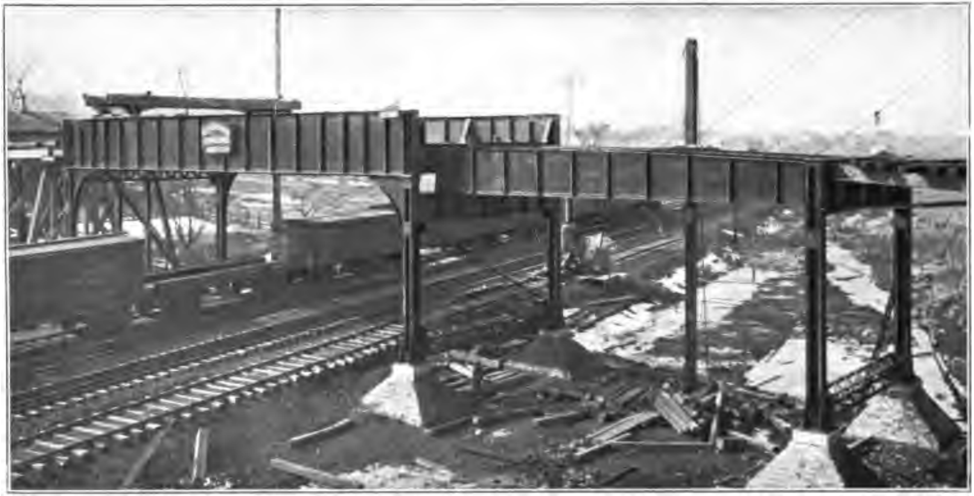
# MEMORANDUM

time, take samples for examination or analysis; and in case any analysis made by direction of the chief engineer shows impurity, adulteration or substitution in these specified materials, the contractor shall pay all the costs of such analysis, and shall moreover thoroughly clean off all metal coated with such impure or unauthorized material and shall repaint it to the satisfaction of the inspector. And the contractor shall, upon demand, exhibit to the engineer or inspector the bills from the manufacturers or their agents, showing the amount of Durable Metal Coating purchased, and also the certificates spoken of in this section; and the Durable Metal Coating shall not be thinned with anything whatsoever, nor shall any turpentine or benzine be allowed upon the premises for any purpose, except by permission of the inspector and in such quantity as he may allow.

IX. The inspector shall be notified when any painting is to be done, and no such work is to be done until the inspector has approved the surface to which it is to be applied; and the contractor shall furnish all facilities for inspection and for necessary marking by the inspector, and all materials, such as paint, brushes, etc., for such marking. No such inspection or marking shall be done except by the engineer or his authorized inspector.

X. In no case shall any paint be applied out of doors in freezing, rainy or misty weather, and all surfaces to which paint is to be applied must be at the time dry and clean; and all work must be done in a thorough, neat and workmanlike manner. If it is necessary in cool weather to thin the paint, this may be done only by heating it, and this may be required by the inspector.

XI. The foregoing specifications shall be accepted and carried out faithfully in every particular and shall not be construed according to any prevalent practice not in full accord therewith.



**ELECTRIC R. R. BRIDGE OVER PENNA. R. R., LONG BRANCH, N. J.**
**Designed by J. G. White & Co., 29 Broadway, N. Y. Painted with our Durable Metal Coating.**
**Edward Smith & Co., 45 Broadway, N. Y.**

# MEMORANDUM

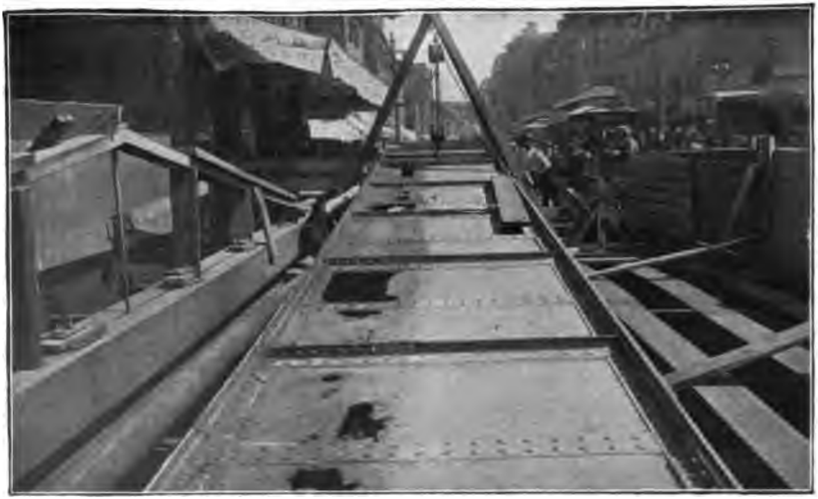
## IV.

# CONCLUSION.

(Reprinted from the Troy Polytechnic.)

Paint is used for two legitimate purposes: First, as a protective covering, preserving the surface to which it is applied from the action of air, water and other destructive agencies; second, for ornamental purposes. In the first of these capacities it must be considered by the engineer; the architect regards both uses.

As a preservative coating it is clearly engineering material. When we design a structure, we adopt a certain factor of safety, say five; this means that we put in five times as much material as is absolutely necessary to carry the load for permanence—for the sake of having it last. The paint is applied for exactly the same purpose—to increase the durability of the structure—and it is just as much a part of the structure as the extra 400 per cent. of steel is, and deserves as careful consideration from the engineer in his specifications and inspection as do the bolts, rivets, the foundation, or any other part of the work. When this view of its importance is fully realized and generally acted upon, a great part of the uncertainties and difficulties which now seem to envelop the subject will disappear. The capable and efficient engineer makes it his business to see that his structures are composed of the best materials and erected in the best manner; and if he insists on having the best kind of a preservative coating, applied in the best and most thorough manner which can be devised, while it is just as likely that he may make mistakes about it as about any other part of his work—and "the man who doesn't make mistakes doesn't make anything"—still it is certain that such a spirit and determination would result on the average in having a pretty good job of work. The first and primary trouble, which underlies everything else, is that paint is regarded as something external and added on, of uncertain value, about which, as there may be honest differences of opinion, it is not worth while to be too strenuous. Its cost is but a small proportion of the



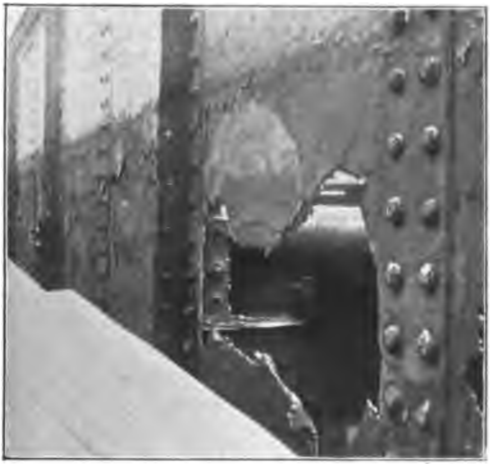
WEST GIRDER. WASHINGTON STREET BRIDGE, BOSTON.

# MEMORANDUM

total amount involved, hence its importance is less. As a matter of fact, the money expended on a thoroughly good job of painting, especially on new work, produces good results far in excess of its proportionate cost, and it deserves the very greatest care. The great enemy of all iron and steel work is rust. It must be remembered that iron does not occur in the metallic state in nature, but as an oxide; we have recourse to the most powerful chemical agencies to reduce it to a metallic condition, and nature is constantly trying to get it back to its original state. Sooner or later the attempt will be successful, and all we can do is to retard the process as much as we can. To show how real is this danger, I will call attention to the accompanying pictures, from photographs furnished by Mr. William Jackson, City Engineer of Boston, of two plate girders recently removed from the bridge which carries Washington St., the most important business street of Boston, over the Boston & Albany Railroad tracks. It will be noticed that only the lower parts of the girders seem to have been attacked. This is because these portions were below the level of the sidewalk and roadway, which confined the smoke and steam from the railway engines, holding these gases in contact with the lower parts of the girders, while the upper portions were correspondingly protected. This bridge was erected in 1871; the girders were wrought iron, and the plates composing the web were ¼ inch thick. Originally the roadway was carried on floor beams depending on these girders; but some years ago, on account of the weakened state of the latter, the floor beams were replaced by girders, so that these old girders only carried the sidewalk, or rather, each carried one-half of one walk, the outer half of each walk having always been carried by a narrow girder put up in 1871, which did not rust much because, being at the extreme outer sides of the structure, the smoke and steam readily passed away from them into the unconfined air. The whole bridge was regularly and frequently painted, and the paint did protect these outer girders; but under the middle of the bridge the conditions were so severe that the paint was rapidly destroyed, and in consequence the progress of corrosion was nearly continuous. It will be obvious to any one who looks at these pictures that unprotected iron or steel is very far from being a permanent substance, and also that if it is possible to protect it by painting it is worth taking pains to have it well done. This is especially true of buildings which depend on a steel frame for strength and rigidity, because the metal work cannot be made accessible either for inspection or repainting, and all that can be done is to make a good job in the beginning. As a matter of fact, these structures get on the average about the poorest class of work in this line. The principal requisite in paint seems to be cheapness; and except in cases where the metal work is done by some reputable bridge company, which has been obliged by the railroad men to take pains with its painting, the sort of painting done by the iron contractor is very often of the most perfunctory sort, such as no bridge engineer would ever accept. It is shameful to see what sort of work the contractors are frequently able to put off on the architects. Often the architect feels obliged to take what he can get, to avoid delay, which would greatly increase the cost of the building.

The bridge engineers, on the other hand, have another excuse. They sometimes say that bridge painting is not an essential part of construction, but of maintenance; let the man who has charge of the latter paint his bridge as often as he likes; all we have to do is to build a good bridge and turn it over to him. This is wrong, because it is easier to get a good job done on new work than after it has become rusty; and in nothing is prevention better than cure more absolutely the case than in this matter of corrosion. It is not easy to prevent rusting, but once started it is next to impossible to stop it.

The most common specifications say that the metal surfaces should be cleaned so as to be free of dirt and scale, and sometimes it is added that



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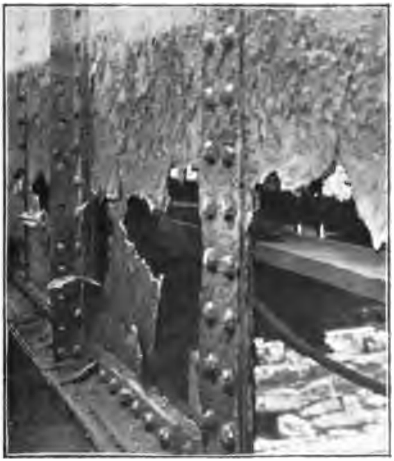
this shall be done by steel wire brushes, with scraping where necessary; this is preliminary to any treatment. Experience and observation have convinced me that paint adheres to a metal surface in the same way that other things do, and that the same conditions which favorably influence the adhesion of other coatings are desirable in the use of paint. For example, when it is desired to coat iron or steel with porcelain or vitreous enamel, it is found necessary to clean the surface by pickling in acid, or by the sandblast or some equally thorough method. When the bicycle maker wishes to make a japan enamel stick to his frames, he cleans them in the most perfect manner on an emery belt, after which they must not be touched even with the finger until the enamel is applied; the tinner cleans the metal with acid before applying the tin; the electroplater does the same thing; except the painters, everyone who applies protective coatings to iron or steel insists, as a matter which will not admit of discussion, on the absolute and fundamental necessity of removing, not all loose scale and dirt, but all scale and absolutely all oxide, so as to apply the coating to the pure metallic surface. Otherwise it has been found that, sooner or later, the oxide will separate from the metal surface, and of course the superimposed coating has to come off. It may be said that if the paint is a sufficiently continuous film, it will keep out the air and water, and in that case there will be nothing to cause the closely adherent scale to separate from the metal. It is a sufficiently complete answer to this argument to repeat that the universal experience shows that nothing can prevent it in practice. If it cannot be done with such a perfect coating as porcelain or electroplate, we cannot expect it with paint, which is in its nature somewhat porous, and with which we have to obtain protection by putting one coat on over another, trusting to the successive coats to fill up the pores and imperfections of those beneath. There is no doubt in my mind that the right way to prepare a steel or iron surface for painting is to clean it so that the



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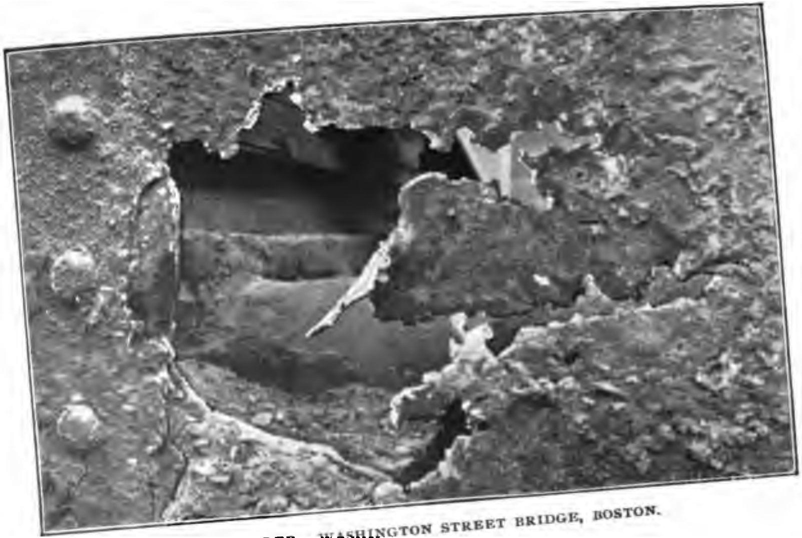
gray color of the metallic iron will be everywhere seen. This may be done in some cases by scraping, in some by pickling, in others by the sandblast; but in all the cost will be considerably more than is now commonly spent, because more work is done and a better result achieved. I believe that money judiciously spent to get a good surface is wisely invested; as I said before, no one doubts that it is if really high-class work is in question. When the metal surface has been cleaned, there are two ways in practice for beginning the work; one is to have a shop coat of boiled linseed oil, and the other a shop coat of some paint which is, or should be, specified by the engineer; each has advantages and disadvantages. The advantage of the shop coat of oil is that it permits more rapid inspection, and, as few engineers have inspectors in the contractors' shops, it provides for the painting being done under inspection; and as the oil coat is supposed to protect the metal from rust only until it gets on the ground, and does not take the place of a coat of paint, it is just so much more protection. The disadvantage is that the contractor may use some other oil than linseed, and thus apply a first coat to the surface which will have a deleterious effect on the paint which is afterward applied. This is not only a possibility, but a very common practice. I happen to know of one manufacturer of a substitute for linseed oil who, at the date of this writing, has more than 100 customers among the iron contractors of New York City; and while I have seen a very large amount of architectural steel and iron work in the last few years in and about New York City, I have never yet seen any with a shop coat of genuine linseed oil, according to my judgment. I do not mean to say that I have made any considerable number of chemical examinations in such cases, but I am very familiar with linseed oil and I do not think I am likely to be mistaken, and I know of such a conclusion having been reached by engineers who have been to the expense of having chemical tests applied. The use of mineral oil, which is common in such cases, is, in my opinion, to be strongly condemned; it is injurious to the paint which is afterward applied, and it gives the unscrupulous contractor a small money advantage over his more honest competitors. There is no difficulty in getting pure boiled linseed oil from reputable makers; it is best to buy it directly from the crushers. It will dry in 24 to 36 hours, but does not make a hard film for some time; in fact, it is always rather soft and tough, but not greasy. The advantage of using a shop coat of paint is that the sooner the paint is applied after the surface is cleaned the better it will stick; the disadvantage is that such painting is rarely done under inspection, and, as the contractor is always in a hurry to get the work out of the shop, he does not like to wait for the paint to dry, and very often thins it with turpentine or benzine, which makes the painting much easier and makes it dry very rapidly, while, at the same time, it saves him money both in materials and labor.

Contract work in painting is almost

always unsatisfactory, and calls for the most thorough and persistent inspection. In order to do the work rapidly, the painter wishes to thin his paint, usually with benzine. To get the inspector to consent to this, he makes a demonstration that the paint is too thick, by using, in the first place, a cheap brush, with the bristles tied around the end of a stick, thus making a hollow brush, having comparatively little capacity, instead of a better brush, which should be practically a solid mass of bristles, and which will hold a large amount of paint; this cheap brush (which, indeed, he intends to use on the whole job) he dips about an inch in the paint and then rubs it over the iron. As there is not enough oil present to lubricate the passing of the brush over the surface, what little there is serves as an adhesive to make the bristles stick to the iron, and the brush "pulls." This is supposed to show that the paint is too thick, and must made more like whitewash by the al addition of benzine and "dry-

What the inspector ought to do



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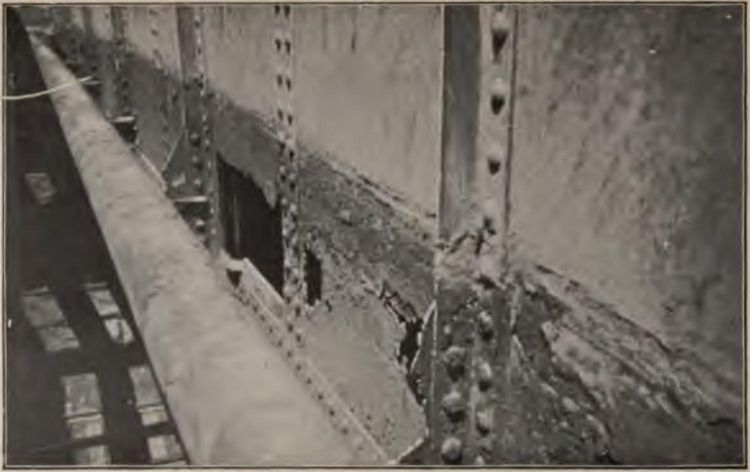
in this case is to dip the brush deep in the paint, so as to fill it, then rapidly paint the surface, stopping as soon as the paint begins to be exhausted, and dipping it again. Before condemning the paint, he should further try it with a first-class brush; and if the weather is at all cold, the paint should be warmed by putting the tin pail which contains it in a bucket or tub of hot water. By using this latter device, it is within my knowledge that extensive jobs of painting have been done by the Calumet and Hecla Copper Company, the Northern Pacific Railroad Company and many others, when the temperature was below 50° F., sometimes as low as 40° F., and using one of the thickest and most sticky paints on the market. Paint should not be put on so as to cover more than 400 sq. ft., one coat, with one gallon of paint, as a rule, and probably no good paint will do it. It might be supposed that thinning paint with a quarter of benzine would reduce the amount of solid material on a square foot one-fourth; but in fact three-quarters of a gallon of paint, which was intended to cover 300 sq. ft., may, by adding to it a quart of benzine or turpentine, be made so light in body that the gallon thus made will cover probably 800 sq. ft.; and if it is a paint containing a well-ground iron oxide or carbon pigment, a coating of this extreme thinness will still be quite opaque, so that the fact that the metal appears to be completely covered is not an indication of sufficient thickness. If the pigment be white, as white lead or zinc, or if the coating be a somewhat translucent varnish, the inspector can judge of the thickness to some extent by the color, especially on the first coat. All these things should be carefully guarded against. Some engineers strictly forbid the presence of turpentine or benzine about the premises, disregarding the workman's plea that he must have it to clean his hands, and so on. In no case should any considerable amount be permitted. Specifications should provide that the contractor must exhibit to the engineer bills from the manufacturer's agent of all the paint used, and that it should all be brought on the premises in the manufacturer's sealed packages, and opened in the presence of the inspector, who shall take samples at any time, and the chief engineer may have the same tested at the expense of the contractor.

Most paints consist of pigments composed of some inert substances, ground or more commonly mixed in linseed oil; and as one effect of nearly all pigments is to retard the drying of oil, it is usual to add dryers. In the paint trade a dryer is a mixture of lead and manganese compounds, dissolved in some medium, sometimes in oil, but oftener in turpentine or benzine, or a mixture of these. These act like the red lead in a storage battery, by taking up oxygen and afterward parting with it, thus serving as carriers of oxygen between the air and the oil. The objection to the use of a dryer is that it may continue to act after the oxidation of the oil has reached its normal, and consequently it is a general maxim that all use of dryers is a source of danger. They should not be allowed to be added to prepared paints, which have already been mixed in the proper proportions by the makers. Care should be taken that all parts of the work receive a coat of paint; if the shop marks, usually in white lead, are allowed to stand unpainted, the inspector should insist that these should be as small and compact as possible, and that special care should be given to these portions of the surface when the second coat is applied. It is to be noted that there is an apparently unavoidable tendency for the paint to be thin on and along the edges; and the best recent practice is to require, after the first coat has been applied and usually after erection, a striping coat of paint applied along the edges and back an inch or two from the edge. After this has become dry, a second full coat of paint is applied. The result is that the equivalent of two full coats is applied over the whole surface. It would be a good plan, when this striping coat is put on, to touch up the rivets also. Paint always tends to draw off from rivets, and they usually are the first spots to show rust. It is desirable to



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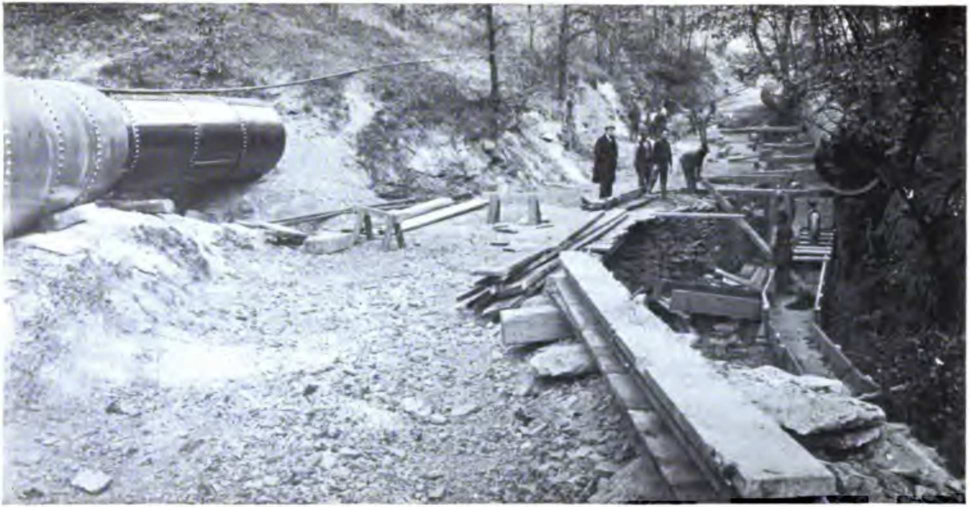
have the paint as full as possible around thin edges. After one coat has been put on, the surface is comparatively smooth, and of course it will not take as much paint for a second coat; but as the brush slides easily over this surface, it is easy for the workman to apply an extremely thin second coat, and the inspector should be on guard against this. The labor is the largest element in the cost of painting, and it costs nearly as much to put on a thin coat as a thick one; the point to aim at is the application of as thick a coat as will be uniform and will dry thoroughly. It is idle to expect much protection unless the paint film is of appreciable thickness. Many of our best architects are requiring three coats on all work which is to be inaccessible, such as posts and beams in buildings. On bridge work it is usually regarded as good practice to apply two full coats, besides the striping coat, if any is used, at first, and wait some months before applying a third coat.

To avoid accidents and to allow greater speed, the railroad engineers are trying to abolish grade crossing, in many cases by depressing the tracks and throwing viaduct bridges over them, which usually are very low. These are subjected to the action of steam, sulphurous and other acid vapors and gases, and to a sort of sandblast action due to the ejection, at an immense velocity, of minute particles of coal and cinder from the stacks of the locomotives. Probably no paint will ever be made which will resist this very long; yet, unless effectually protected, the metal will be rapidly corroded. It becomes necessary, therefore, to paint these bridges frequently, and they are probably the most difficult structures to deal with which the painter is likely to find. In the first place, they should be very thoroughly painted with three or four coats of paint, and allowed abundance of time for drying, before they are erected. I believe it is absolutely indefensible practice to allow them to be erected before painting, yet it is too often done. Second, when it becomes necessary to repaint them, we encounter the following difficulties,

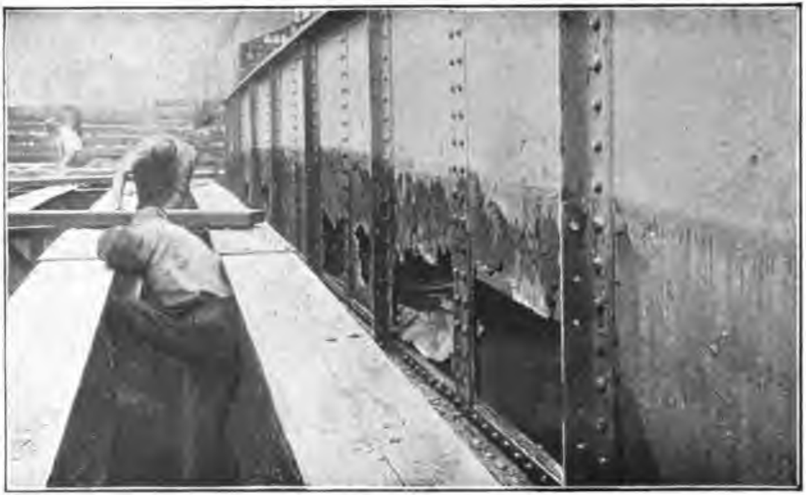


Allegheny, Pa. Robert Swan, City Engineer. T. A. & R. G. Gillespie, Contractors. About 9½ miles of 60-in. steel plate riveted water pipe, two sections of which are here shown, was protected by our "Sabin Process" Baked Coating in 1895. The field riveted joints, and other places where baking was impracticable, were protected with our Durable Metal Coating.

among others: They are often so low that work can be carried on only in the intervals between trains. This is likely to prevent the thorough cleaning and scraping which such surfaces need more than any others, and also causes the painting to be done in a hurried and piecemeal way; as trains are frequently passing, the paint gets blown off while it is still fresh, and its adhesion is comparatively small. Where there is room enough, it is desirable to put up a movable wooden screen of boards to protect the paint for a week or so. The force of the exhaust was shown at the last repainting of the Sixth Street viaduct in St. Paul, a few years ago. This is a rather high bridge, and the painters worked on a platform of 2-in. planks; and when a freight engine, heavily loaded, passed underneath, going up grade, the exhaust lifted the plank platform with two men on it several inches vertically. It is difficult to make paint adhere well in such a place; yet there was several feet of head room, while there are very many viaduct bridges with less than

1½ ft. above the locomotive stacks, and there are some in New England where the ventilators on the passenger coaches sometimes are damaged by scraping along the bottom of the bridges. How to paint these latter places is too difficult a problem for me.

The best time of the year for outdoor painting, especially of bridges, is in the hot summer weather. When the weather is hot, the paint spreads and flows well, and it is practicable to use a paint having heavy body, which is, in general, the best. The paint dries rapidly; hence we can use a paint with little or no dryer. The work may begin in the morning and continue all day, while in the spring and autumn a bridge, which is usually over a stream and often in a somewhat secluded place, is likely to be covered with dew until the middle of the forenoon, and the dew begins to deposit on it before it is time to quit work in the afternoon. Nothing is much worse than applying paint to a wet or damp surface. A deposit of moisture may occur on iron from another



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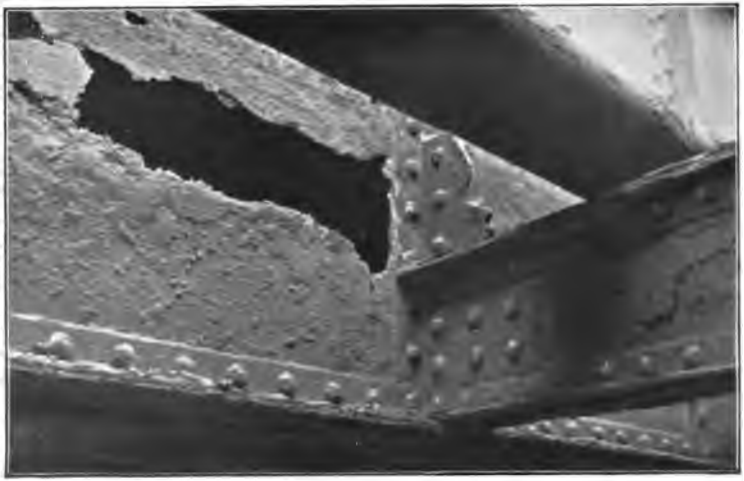
cause. Some of the paints in use are thinned with benzine or have as a vehicle a benzine varnish, and some are merely solutions of coal tar or asphalt in benzine. When these are applied to iron work, the rapid evaporation of the solvent cools the metal; and if the atmosphere is nearly saturated with moisture, the latter is condensed on the cold surface in advance of the painting. The engineer who is responsible for the work will therefore exercise particular vigilance when using such materials; and he should keep careful memoranda about the weather and all the conditions when the paint was applied, so that in the future some intelligent conclusions in regard to the value of the material used may be reached. A poor paint applied under favorable conditions to a good surface is undoubtedly better than a good paint applied under unfavorable conditions to a poor surface, and often it is difficult to learn what has really taken place after two or three years have elapsed.

There are some particular cases of painting which deserve notice. One is the painting of a tin roof or similar surface. The painters' tradition is that it is impossible to paint a new tin roof; that it must be left until it has become slightly rusty, when the paint will stick to it. There is no doubt that a new tin surface is very difficult to paint. The fault is not, however, in the tin itself, to which paint adheres very well, but in the coating of grease or other material with which new tin is covered. There is some diversity in the methods employed in making tin plate, and consequently it is not all alike, and some brands of new plate hold paint better than others; but as a rule it is covered with grease, either tallow or palm oil, and sometimes with other substances. These act on the paint in a very destructive manner. The obvious remedy is to have the tin roof thoroughly scoured and cleaned before painting, and the whole should be done as soon as possible after the roof is finished. Do not be persuaded by any one that rust good thing to paint over.

alvanized iron (that is, iron which a coating of metallic zinc) is even



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worse to paint than tin. It is coated with grease and usually with chloride or sulphate of zinc, or a mixture of the two; and not only does the paint come off, but in many cases the metallic surface flakes off, bringing the paint with it. I do not know of any certain remedy except repainting; the second painting usually proves durable. Dr. C. B. Dudley, of the Pennsylvania Railroad, informs me that they have not found any paint which will uniformly adhere to new galvanized iron, and I believe that is a practically universal experience.

Smokestacks are sometimes difficult on account of their high temperature. It is probable that nothing will stand on a surface which has a temperature of 400° F. or over, because, although the pigment may be unaffected, the vehicle, which acts as a cement to hold the pigment together, is gradually decomposed, and in a short time the coating begins to come off. There is, however, a great difference in this regard in different coatings.

In painting water tanks and other hydraulic work, care should be taken to select a paint which is acted on as little as possible by water; have the surface as clean as possible, and perfectly dry, and allow the coating plenty of time to dry before filling with water. Remember that paint on the interior surface of a nearly closed tank dries slowly.

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# ADVERTISING SUPPLEMENT

# DURABLE METAL COATING

Numerous inquiries have shown that information is frequently desired in regard to certain points, which is thus supplied by the manufacturers, Edward Smith & Company, of 45 Broadway, N. Y. City.

**Color.**

**May Paint Over It.**

**May Color It.**

The color of Durable Metal Coating is black. It is practicable to apply paint of any color over it; two coats of white zinc or white lead cover well, and if the desired color is of a neutral or dark shade one coat is often quite sufficient. If it is desired to throw it off color only a little, the painter may add to it pigments either dry or ground to a paste in oil; for example, a bronze green suitable for certain ornamental iron work in parks, etc., may be had by adding a little chrome green, or olive by medium chrome yellow. For engineers who desire to use different colors in successive coats we will send enough chrome yellow ground in our Metal Coating to color it dark olive without extra cost, if the order is of considerable amount. But it gives a very handsome and permanent black finish to iron and steel which is generally

liked, black being commonly regarded as the natural and proper color for iron.

Area Covered.

One gallon will cover from 300 to 400 square feet, according to the character of the surface. If the latter is very rough, owing to corrosion, it may not cover more than 250 square feet the first coat, because in that case it acts as a filler, but it will cover more than 300 square feet for the second coat. There is not a great difference in the amount of surface covered by different paints; almost any paint may be made to cover five or six hundred square feet by spending labor enough on it brushing it out thin; but this is not done because the labor costs more than the paint, and it never should be done, because such a coating is too thin to afford any protection. Paints may be made to cover more surface if they are made very thin with benzine or turpentine, but such are of little value.

Covering Capacity of Different Paints.

Ready to Use.

Durable Metal Coating is supplied ready to use, and must not on any account be thinned with anything. It is a perfect liquid, contains no pigment, does not require stirring, and

Do Not Stir It.

Packages.

For Hot Countries.

can be used to the last drop in the barrel. It is usually sold in barrels, but will be put up in packages of any size, smaller packages being charged extra at their cost to us. It is shipped to India and other hot countries in 100 gallon drums, or in sealed cans, barrels not being suited for holding liquids in hot countries.

No Skill Required.

In Cold Weather.

It is not necessary to have skilled labor for its application. If it is necessary (as it often is) to use it out of doors in cold weather, it may be heated to make it more fluid. Thousands of gallons have been thus treated by the Calumet and Hecla Copper Co., the Northern Pacific R. R. Co. and others.

Time for Drying.

It is commonly estimated to require about thirty-six hours to dry so that it may be handled, and from three or four days to two weeks for it to dry through. It does, however, continue to harden for at least two weeks, and in cold or wet weather it may require two days to dry so it may be handled, while in hot, dry weather it has been known to dry in ten or twelve hours.

Second Coat.

A second coat should not be applied in less than three days, and a week or ten days is much better. In fact, in bridge work it is good practice to allow two to four weeks between coats, with any kind of paint. But if it can be dried by heat, as is the case with much ornamental iron work and with small objects generally, it will dry in an hour or two at 200° to 250°. It dries by oxidation, and heat accelerates this process.

In Hot Room.

No Guarantee.

We do not give any guarantee of performance. No reputable manufacturer can afford to do this, not knowing the character of the surface to which the paint is to be applied, the intelligence of the man who applies it, the treatment it is to receive, or any of the many things which affect the durability of paint or varnish. If the reader will take the trouble to look up with the aid of any of the commercial agencies the standing of the paint manufacturers, he will find that no one having a considerable rating offers a guarantee. This fact speaks for itself. He may also notice that some of the concerns which give recommendations for certain paints are not mentioned in the books of the commercial agencies.

**Avoid Imitations and Frauds.** Edward Smith & Company desire to call attention, especially on the part of architects and engineers, to the fact that it is desirable to specify "Durable Metal Coating made by Edward Smith & Co., of 45 Broadway, N. Y.," because at least one concern is sending its agents around to our customers offering to sell them a paint under the same name and guaranteed "equal to Smith's," at prices varying from 90 cents or $1.00 per gallon, in the case of architects, to as low as 12½ cents a gallon to the large steel companies. This paint is not worth 12½ cents per gallon, and will not be satisfactory to people who want Edward Smith & Co.'s goods; and it has been used when the latter were specified. Therefore take warning.

**Look Out.**

**Surface.** While we strongly recommend thorough cleaning of all surfaces which are to be painted, we do not wish to be understood as meaning that our paint cannot be applied to any but a clean metallic surface. It has been and is constantly being used as a protective coating

**Over Red Lead.** over red lead (on the ground

**Over Old Paint.**

that the good qualities of the latter depend on its protection from the atmosphere), and there is no serious objection to using it over old paint which is in good condition and adheres well.

**Bridges.**

**Water Towers.**

**Pipe Lines.**

**Roofs.**

**Handrails.**

**ks.**

Durable Metal Coating is recommended for painting railway and other bridges, the interior as well as the exterior of train sheds, also for steel frame buildings. It has given general—in fact, so far as we know, universal—satisfaction as a coating for steel water tanks connected with public and private water supplies; has been used for several years on water pipes, both steel and cast iron. We advise its use on metal roofs of all kinds; but if used on new tin or galvanized iron, care should be taken to clean the same very thoroughly before beginning to paint, by scrubbing with soap and water, and, if greasy, with benzine. It makes a handsome and durable paint for handrails and ornamental iron work. As it is not affected by a considerable degree of heat, it is the best coating we know of for smokestacks, steam-pipes, boiler fronts, and the like. It has been successfully used for painting tanks to contain strong muriatic acid and 40% sulphuric acid, and is not readily affected by acid fumes or smoke. It does not appear to be affected by fresh water, and is used by the U. S. Navy Dept. for painting water tanks and the interior of water tank ships; nor is it acted on by the spray from sea water or by a few days' immersion in the same, but we do not recommend it for constant use in sea water, as it after a time becomes softened, and may then be scraped off. It has been and is being used for painting the entire interior metal surface and the exterior above water of torpedo-boats. Besides being in other respects well fitted for this, it has the additional advantage of weighing only eight pounds to the gallon, against thirty pounds for red lead, thus effecting in the aggregate a considerable saving in weight.

**Acids.**

**Sea Water.**

**Torpedo Boats.**

**Theory of Paints.**

The durability of a protective coating depends on the liquid portion of it. The dry pigment itself would, if possible, of course, readily fall or be brushed off; the oil or other vehicle serves as a cementing substance or "binder" to hold it on. If this cementing material perishes the pigment falls off; and if it is porous the air and water have access, and there is no protection. If the pigment is a neutral substance, inactive to the oil, it seems obvious that we depend on the latter for preservation, the pigment affording color for decorative effect. Now, it is perfectly well known, and has been for a great many years, that a properly made varnish is more durable, far less porous, and less easily acted on by chemical and physical agencies than oil. Railway coaches, for example, are painted with great care and skill for decorative effect, then they receive two or three coats of varnish to preserve the paint; and in this work the paint itself usually, if not always, has a varnish as a vehicle. Why, then, is not varnish used instead of oil as a vehicle for ordinary paints? Simply because of the expense. Varnish paints are always used when the expense does not forbid it. If, therefore, we need the best

**Varnish Better Than Oil.**

protective effect, we should use either a varnish or a varnish paint. Edward Smith & Co. have been engaged in the manufacture of both these classes of products for more than seventy years, and have acquired a large stock of empirical knowledge. They also maintain a laboratory and constantly conduct experiments and investigations.

**Verdict of Experience**

**Cheaper To Use Pigment.**

It is our opinion that if the question is only one of protection from corrosion, there is no advantage in adding a pigment to the varnish; the latter alone will make a film of reasonable thickness, and so far our best results have been obtained from such a film. There is a substantial reason why we should desire to use a pigment; if we could use graphite, for example, which is a cheap and bulky material, we could reduce the cost of our product considerably, which would enable us to sell it at a lower price, and would without question greatly increase our sales; but, while we are constantly conducting experiments, at large expen
to see if we cannot do so
thing of the sort, the result

far have all been negative, and do not venture to advise our friends to try anything of the kind.

**The Best Coating.**

The best varnish for the purpose is one made of suitable resinous material, containing a certain proportion of the best and hardest asphaltum (Gilsonite) and a considerable amount of linseed oil, thoroughly united by methods known to experienced varnish makers, and should contain no solvent except turpentine, and not too much of that.

**What To Avoid**

Cheap varnishes, made with rosin, coal-tar, soft asphaltums, benzine, and the like, or those made by inexperienced persons, are of little or no value. The best is none too good.

**What To Get.**

Get the best; it is

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